A study to evaluate patients with pelviureteric junction obstruction who underwent dismembered pyeloplasty between January 2006 and December 2011

A DISSERTATION SUBMITTED TO THE DR. M.G.R.MEDICAL UNIVERSITY, TAMIL NADU, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE MCh. PAEDIATRIC SURGERY EXAMINATION TO BE HELD IN AUGUST 2013

CERTIFICATE

This is to certify that the dissertation entitled is the original work of

Dr. Jehangir Susan Homi

during her course from 2010 till 2013

Submitted in partial fulfilment toward obtaining the

MCh Degree (Paediatric Surgery) of the

Tamil nadu Dr. M.G.R. Medical University

Dr Alfred Job Daniel

Principal

Christian Medical College and Hospital

Vellore

Dr Sudipta Sen

Professor and Head

Department of Paediatric Surgery

Christian Medical College and Hospital

Vellore

August 2013

ACKNOWLEDGEMENTS

I am grateful to Dr. Sudipta Sen, my guide and mentor for taking me under his wing and turning meaningless numbers into significant findings. His untiring enthusiasm toward the subject and children has always been an inspiration to me.

To Dr. Sampath Karl for simplifying complicated and confusing issues which would have otherwise hindered my progress.

To Dr. John Mathai and Dr Reju Thomas for their encouragement and for giving me enough time to work on my thesis.

To my colleagues Dr Pradeep Ninan, Dr Ravikishore and Dr Sundeep for helping me with all the technical details.

To my peers for tolerating my distraction.

To my parents of making my life easy so that I can accomplish my potential.

To my husband for always encouraging me to do better than myself.

To my little daughter Alanna for being the one distraction that has ironically helped me keep my focus. For gracefully forgiving me for being away from her so much.

Last but not the least I thank the little children and their parents who so trustingly allow us to operate on them. I hope we will be able to serve them better.

TABLE OF CONTENTS

INTRODUCTION

Pelviureteric junction obstruction (PUJO) or Ureteropelvijunction obstruction (UPJO) is the commonest cause of hydronephrosis in children. Once obstruction has been diagnosed the surgeons main priority is to decide whether the child requires an operation.

There are many controversies with respect to approach, degree of invasiveness and timing of surgery. The objective however is the same in all approaches: to preserve renal function in the least morbid manner with the best possible outcome.

Anderson-Hynes dismembered pyeloplasty has been used for more than 50 years and it remains the surgical treatment of choice for paediatric PUJO. Although there have been many modification the basic operative technique for dismembered pyeloplasty is universal, involving excision of the pelviureteric junction and redundant pelvis when necessary, and re-anastomosis of the healthy ureter to the renal pelvis(1).

The postoperative follow up of patients involves ultrasound and diuretic renal scan. This yields structural and functional assessment of the operated kidney. However since the success rates of pyeloplasty are as high as 97% it seems unnecessary to expose 100 children to ionizing radiation to find the 2 or 3 who might have postoperative obstruction. Postoperative follow up with ultrasound is being explored as a viable alternative with diuretic renal scan reserved for doubtful cases(2).

AIMS AND OBJECTIVES

AIM: The purpose of this study was to evaluate patients with pelviureteric junction obstruction who underwent dismembered pyeloplasty between January 2006 and December 2011 in Christian Medical College and Hospital, Vellore.

OBJECTIVES:

1. To analyse the presenting symptoms and their resolution after surgery.
2. To evaluate the difference between the pre and post operative split renal function and drainage patterns by renal sinctigraphy.
3. To assess if there is resolution of hydronephrosis post pyeloplasty by renal ultrasound.
4. To study the different patient profiles and assess if there is a difference in outcome in them i.e. antenatally detected, supranormal functioning, type of stent used etc.
5. To study failed pyeloplasty.

REVIEW OF LITERATURE

INCIDENCE

Pelviureteric junction (PUJ) obstruction is a chronic partial or intermittent obstruction due to an intrinsic defect in motility across the PUJ or extrinsic compression which impedes the passage of urine from the renal pelvis to the ureter.

PUJ obstruction (PUJO) is the commonest cause of foetal hydronephrosis with a reported incidence of about 1:750 to 1:1000 live births. PUJO is usually unilateral affecting the left side twice as commonly but may be bilateral in 10 to 15% of cases. In newborns, the male to female ratio is 2:1.

ETIOPATHOGENESIS

The causative factor for PUJO may be intrinsic, intramural or extrinsic

Intrinsic

- **Aperistaltic segment.**

  An aperistaltic segment at the PUJ impedes the flow of urine across it Figure 3.1(a). It is characterised by a poorly distensible segment of variable length which may be probe patent. The etiology remains unclear. Various factors like incomplete recanalisation of the ureter during development, abnormal innervation and disordered architecture of the muscle with abnormal collagen deposition have been hypothesized.

- **High insertion of the pelviureteric junction**

The PUJ is inserted high on the pelvis and distension of the pelvis causes obstruction of the nondependent ureter.

<u>Intra mural</u>

- **Ureteric folds**

The PUJ is normal and patent but the proximal ureter is tortuous and kinked. Figure 3.1(b). Straightening of these folds with growth may explain the resolution of PUJO observed in some antenatally detected cases.

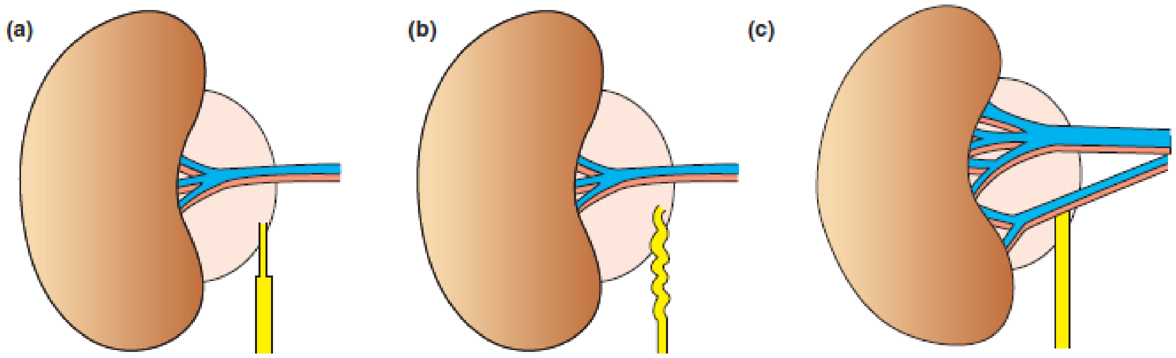
- **Ureteric polyps**

These rare fibro epithelial polyps are usually seen in the mid ureter.

<u>Extrinsic</u>

- **Aberrant lower pole vessel**

Crossing lower pole vessels causing kinking of the ureter account for about 30% of obstruction in older children. Figure 3.1(c).



(a) Intrinsic stenosis. **(b) Ureteric folds.** **(c) Crossing lower pole vessel**

Figure 3.1 Etiology of pelviureteric junction obstruction. (from Essentials of Paediatric Urology, 2nd Edition)

<u>Other causes of PUJO</u>

- **Retrocaval ureter**

This is due to the abnormal development of the posterior cardinal veins within which the ureter is trapped and obstructed.

- **Horseshoe kidney**

This is the most common complication of horse shoe kidney and may be due to compression of the ureter by an aberrant vessel or distortion as it passes over the distended isthmus Figure 3.1.d.

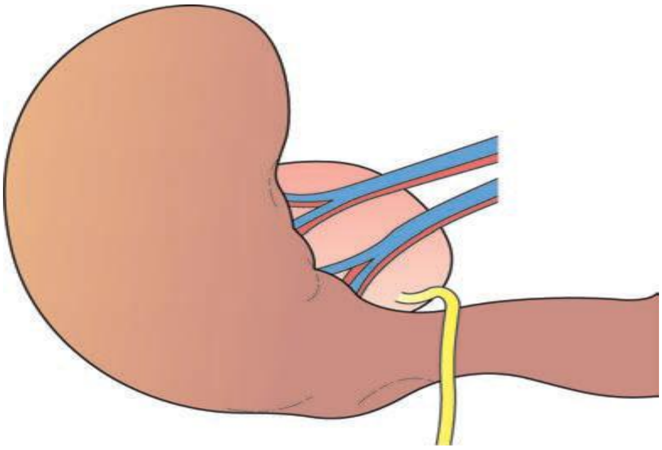


Figure 3.1.d : horseshoe kidney causing obstruction at the PUJ (from Essentials of Paediatric Urology, 2nd Edition)

- **Vesicoureteric reflux**

Major grades of reflux cause tortuosity and kinking of the ureter leading to secondary PUJO.

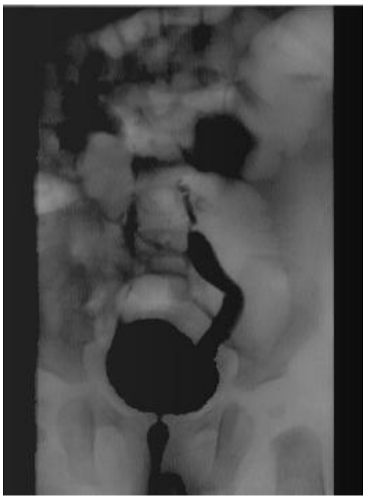


Figure 3.1.e : MCU showing major reflux causing kinking at the PUJ

PRESENTATION

With advances in foetal ultrasound screening and its widespread usage, ***antenatal*** detection has become the commonest mode of presentation.

In children who have not been identified by foetal ultrasound, flank ***pain*** is a common presenting complaint. Older children with a crossing vessel might present with intermittent pain with a palpable mass which is relieved with diuresis called ***Dietels crisis.***

It is not uncommon for a child with PUJO to present with a ***urinary tract infection*** which, in some instances may progress to ***pyonephrosis.***

A grossly hydronephrotic kidney may present with a ***palpable mass.*** Trivial trauma may cause ***hematuria***. Occasionally the PUJO may be detected ***incidentally*** while evaluating the child for some unrelated symptom. Newborns with a massive hydronephrosis can rarely present with a ***urinoma*** at birth.

DIAGNOSTIC EVALUATION

The wide spread use of antenatal ultrasound has helped identify many infants with hydronephrosis; all of whom may not have a functional obstruction requiring surgical intervention. The diagnostic armamentarium available needs to be used judiciously to establish the cause of hydronephrosis and determine the degree of obstruction

Antenatal ultrasound

The routine use of prenatal ultrasound has lead to the early detection of hydronephrosis. This has shifted the patient profile from symptomatic older children to largely asymptomatic newborns.

A few concerns have emerged from the widespread use of prenatal ultrasound. Firstly, the lack of consensus regarding the definition of hydronephrosis. Secondly, the correct evaluation and management of asymptomatic hydronephrosis(3).

The Society for Foetal Urology (SFU) classification of foetal hydronephrosis (table 3.1) provides a guide to the prognosis and need for postnatal evaluation. Grades I and II will require a postnatal ultrasound to reassess the kidney and a MCU to rule out reflux. The higher grades require functional evaluation and will most likely require corrective surgery.

Table 3.1 SFU grading scale for hydronephrosis detected by US

Grade	**Central renal complex (pelvis and calices)**	**Renal parenchyma**
I	Slight splitting	Normal
II	Evident splitting; confined within renal border	Normal
III	Wide splitting; pelvis dilated outside renal border; calices dilated	Normal
IV	Wide splitting with pelvis dilated outside renal border; calices dilated and may appear convex	Atrophy

Bouzada et al took into consideration the anteroposterior diameter (APD) after 28 weeks of gestation. They found that an APD ≥ 15mm has sensitivity of 82.4% and specificity of 87.9% to identify renal units that will require medical or surgical treatment [(4)].

Addressing the second issue of asymptomatic hydronephrosis, a meta analysis done by Lee et al highlights the dilemma regarding the treatment of mild and moderate hydronephrosis which have a risk of pathology of 11.2% and 43.5% respectively(5). The global consensus is toward conservative management in asymptomatic infants less than 6 months of age(3). Yi Yang et al in their long tern follow up of antenatal hydronephrosis found that SFU grades I and II did not require surgical intervention. Greater improvement occurred in children with differential renal function less than 40% but it did not recover to predeterioration levels postoperatively. They recommended earlier intervention following a short period of strict surveillance for preservation of renal function(6). Postnatal ultrasound has become a cornerstone in the evaluation of children with antenatal hydronephrosis. The recommended timing of the postnatal scan is between 4 to 7 days of life(7).

Ultrasound

Ultrasound is inexpensive and non-invasive, does not expose the child to ionizing radiation and is not limited by renal failure. This makes it an excellent tool for screening and follow-up. The size of the kidney, the cortical thickness and the anteroposterior diameter indicating the degree of dilation can be measured and compared with age appropriate normograms. It is however operator dependent, cannot diagnose obstruction and does not give any functional information. The quality of the scan can be limited by body habitus, excess bowel gas and lack of patient cooperation.

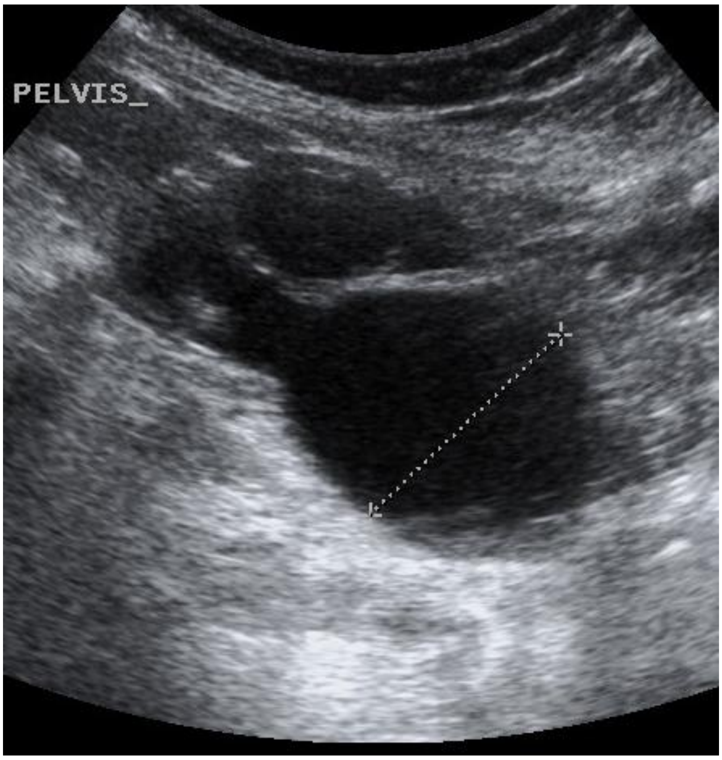


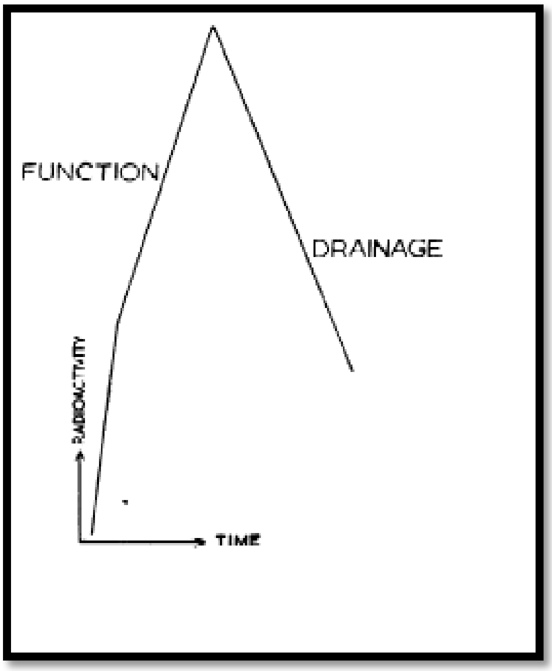
Figure 3.2 : US measuring the AP diameter

Diuretic Renal scintigraphy(DRS)

Once the diagnosis of hydronephrosis is made, the next step is to establish function of the renal unit and the degree and level of obstruction. DRS is commonly used in the diagnosis and follow up of children with PUJO and for postoperative evaluation following pyeloplasty.

The radiopharmaceuticals used in DRS comprise a radionuclide (Technetium 99m), bound to a carrier macrolide. Technetium 99m-diethylenetriaminepentaacetic acid (99mTc-DTPA) and technetium 99m-mercaptoacetyltriglycine(99mTc-MAG-3) are currently the preferred radionuclides used in suspected PUJO. They are both preferentially concentrated by the kidney and freely filtered by the glomerulus. DTPA is neither secreted nor reabsorbed by the renal tubules, whereas MAG-3 is secreted by the tubules(8). Technetium-99m-L,L-ethylenedicysteine (^{99m}Tc-EC) is a relatively new agent and is now being widely used for DRS(9, 10).

Figure 3.3 Normal renogram from one renal unit.



Dynamic renal scintigraphy allows estimation of three parameters of renal function: blood flow to the kidney, renal clearance (11) and excretion from the kidney (obstruction). Figure 3.3 shows a normal renogram from one renal unit. The initial steep upstroke represents radioactivity in the aorta and abdominal vasculature and lasts of 30 to 60 seconds. The second part of the rise reflects renal uptake i.e. function and takes 2 to 4 minutes to reach its peak. The subsequent downslope is the excretory phase(12). The clearence half time of a normal renal unit after furosemide administration is less than 10 minutes. A delay of 20 minutes or more is associated with significant obstruction. Values between 10 and 20 minutes are considered intermediate.

Clearence half time in isolation however cannot be used to diagnose obstruction. Other factors like differential renal function(DRF) and curve analysis along with ultrasound findings and clinical data determine the presence of obstruction especial postoperatively(13). Nam et al used a modified DRF measurement calculated according to cross-sectional area which they claim had fewer false negative results(14). This could be particularly useful in equivocal circumstances.

In the present clinical context DRF largely determines the intervention. A DRF of more than 35% would warrant conservative treatment if the degree of hydronephrosis is within acceptable limits. Any function less than 35% on the initial scan or a decrease in function of 10% on follow up scans would be considered for pyeloplasty.

DRS needs to be interpreted with caution in poor or immature renal units and in massively dilated pelvises. Other factors like the region of interest, time of measurement, state of hydration, bladder fullness, reservoir effect, type of protocol and renal response to furosemide can influence the results of differential function(15).

The concept of supranormal function, i.e. DRF more than 55% in the obstructed kidney, has been much debated. There is no consensus regarding the significance or causes of this phenomenon. Ham et al rule out the theory that supranormal DRF is due to an increased nephron volume(16). Oh et al(17) and Capolicchio et al(18) believe that supranormal function is an adverse prognostic factor.

Micturating cystouretherogram (MCU)

MCU was routinely used in the investigation of antenatally detected hydronephrosis. An MCU is an invasive unpleasant experience for most children and some authors have challenged its routine usage(19). It is reserved for children with bilateral hydronephrosis or a dilated ureter on ultrasound and those with a history of febrile UTI and hydronephrosis.

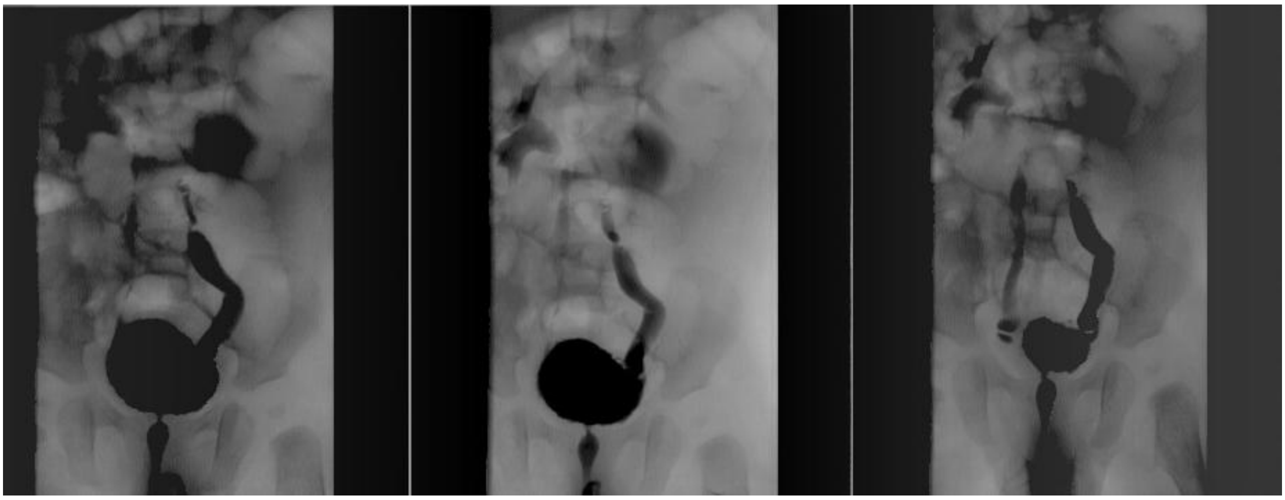


Figure 3.4: MCU showing bilateral major reflux with PUJO

Magnetic Resonance Urography (MRU)

MRU is the most recent addition to the armamentarium of investigations for renal anomalies. It offers excellent anatomic resolution and soft tissue contrast without using ionizing radiation. The use of Gadolinium has enhanced the MRU further by providing it functional capabilities comparable to DTPA(20). The drawback lies in the need for sedation or anaesthesia in children and the cost and availability. Also spatial reconstruction and interpretation is a cumbersome process.

Intravenous pyelography (IVP) and Whitaker test

Intravenous pyelography and Whitaker test are mentioned only for completion. IVP is helpful in delineating anatomy clearly but is inaccurate if function is poor, requires use of nephrotoxic contrast and involves radiation exposure.

Whitaker test is the only study that measures directly the pressure in the renal pelvis/bladder. It is however invasive, not reproducible, gives no functional information and involves radiation exposure.

Retrograde pyelogram (RGP)

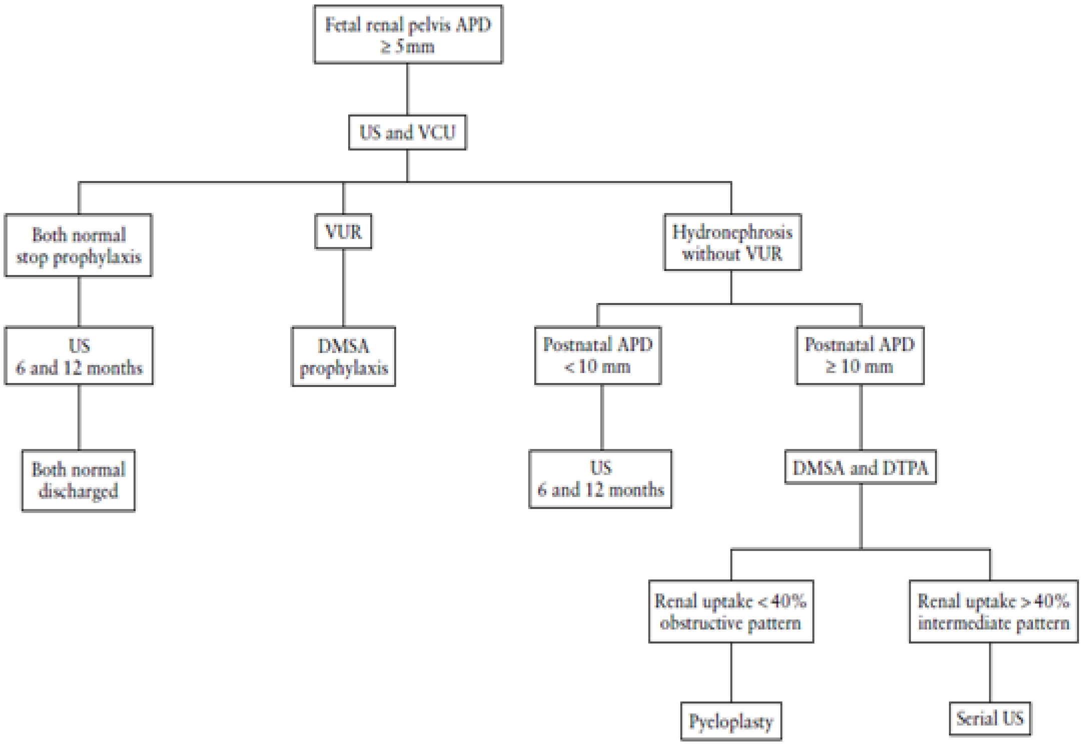
An RGP is not essential in the diagnostic work up of PUJO. It however precisely identifies the location of obstruction and rotation of kidney and excludes the presence of distal obstruction.

Biochemical markers

The use of transforming growth factor b1(TGF-b1), monocyte chemotactic protein 1 (MCP-1), and endothelin-1 is under review.

INVESTIGATION ALGORITHM FOR ANTENATAL HYDRONEPHROSIS

Figure 3.5: Algorithm proposed by Bouzada et al(4) for the investigation of antenatally detected hydronephrosis.



MANAGEMENT

In the past, children with PUJO presented with symptoms. It was thus logical to operate to relieve those symptoms. The indications for pyeloplasty in asymptomatic children with prenatally detected PUJO remain controversial. The end point of all approaches remains the preservation of renal function. Discussed below are the various approaches, controversies and guidelines.

Observation or early surgery?

There are two opinions regarding the initial management of PUJO – watchful waiting or early surgery. There is now a global consensus toward initial observation instead of surgery in the newborn period and infancy(3). Strict surveillance is required when a child is being treated conservatively and caregivers must understand the need for close follow up(5).

The proponents of early surgery believe that renal function does not recover after pyeloplasty to the predeterioration status. It is thus not necessary to wait for deterioration. Rather it is better to operate early and preserve maximum function in the obstructed kidney(21).

When to operate?

The indications for pyeloplasty can be briefly summarised as:

- Symptomatic PUJ obstruction, e.g. pain, infection, palpable renal mass.
- Asymptomatic obstruction with reduced function (less than 35–40%) at the time of initial evaluation, particularly if the AP diameter of the renal pelvis exceeds 30 mm

• Failure of conservative management, i.e. deteriorating function of more than 10% or increasing dilatation.

• Persisting asymptomatic obstruction with increasing dilatation with stable differential function(22).

Which operation to perform?

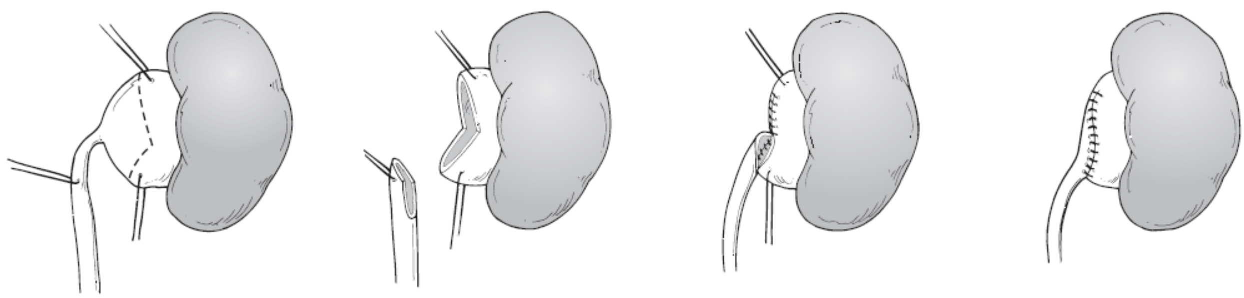
There several surgical options and although the Anderson Hynes pyeloplasty is the most popular operation a knowledge of the other techniques is useful.

Pyeloplasties are broadly divided into dismembered and non dismembered.

Dismembered pyeloplasty

The dismembered pyeloplasty described by Anderson Hynes involves the excision of the adynamic segment of the PUJ and reanastamosis to the pelvis with or without pelvic reduction.

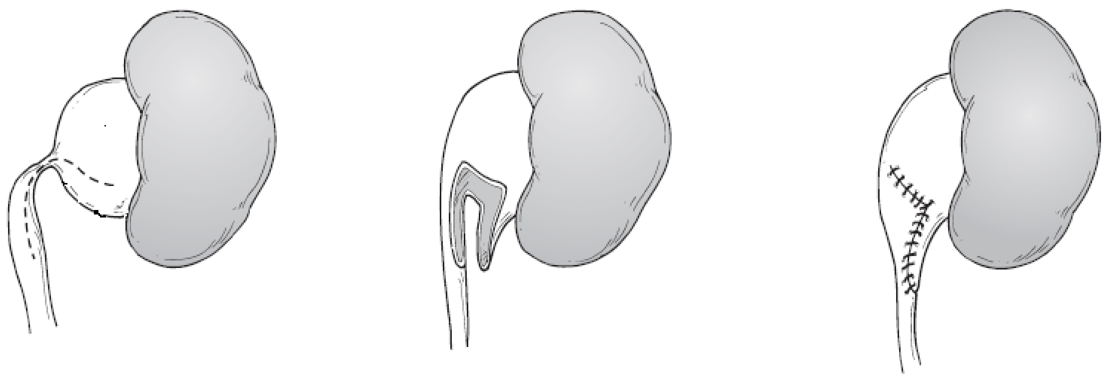
Figure 3.6.a: Anderson Hynes pyeloplasty



Non dismembered pyeloplasty

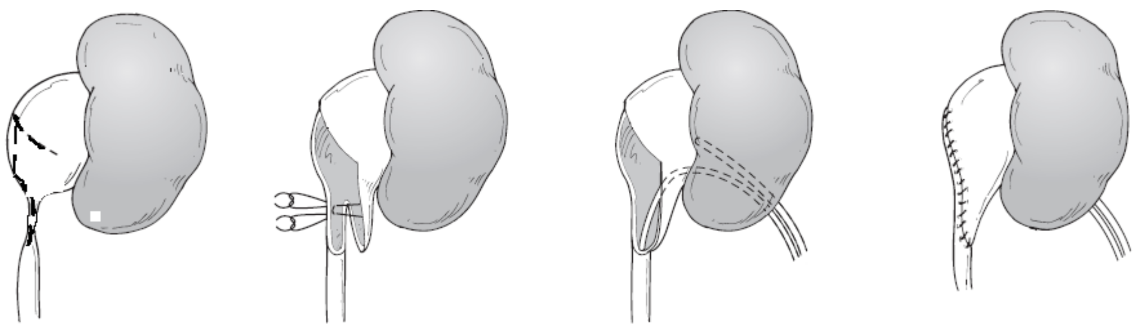
The non dismembered pyeloplasties used different flaps of the dilated pelvic tissue to widen the narrow PUJ.

Figure 3.6.b: Foley Y-V plasty



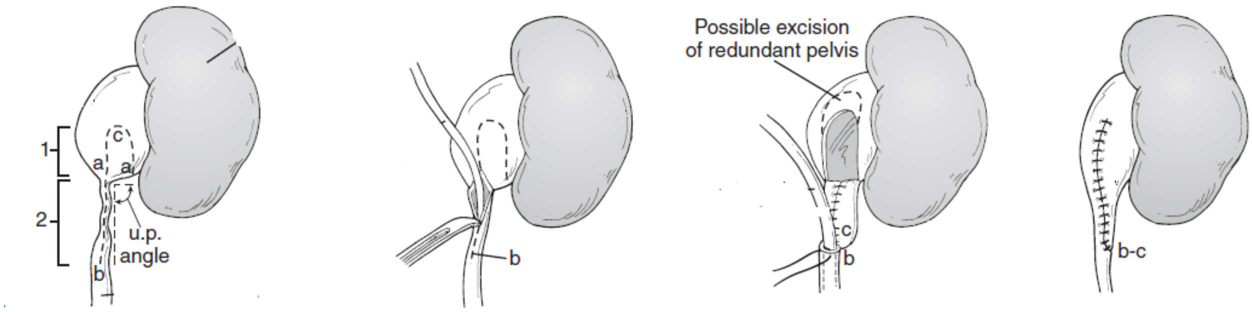
The Foley Y-V plasty makes a Y incision from the ureter to the pelvis and converts it to a V. It is useful in cases of high insertion of the ureter

Figure 3.6.c: Culp De Weerd spiral flap pyeloplasty



The Culp–DeWeerd spiral flap pyeloplasty uses a spiral flap which is used to bridge the gap in the ureter and is especially useful in long segment strictures(23).

Figure 3.6.d: Scardino and Prince vertical flap



Scardino and Prince use a vertical flap (Fig d). This is useful in a dependent PUJ with a large square extra renal pelvis(24).

<u>Tissue handling and Suture material used?</u>

The judicious use of traction sutures allows for minimal handling of the pelvis and ureter. Handling leads to more postoperative oedema. Stentless operations especially require minimal handling of the tissues.

An avascular plane is usually located outside the intrinsic blood supply of the pelvis. Recurrent preoperative infection or urinary leak causes fibrosis and mobilization of the pelvis is more difficult.

The use of absorbable monofilament sutures is preferred. The use of finer suture materials like 5-0 to 7-0 has made possible a water tight anastamosis. Suturing is started at the apex and attention must be paid to maintaining a patent lumen. Continues or interrupted sutures may be used.

Stented versus non stented pyeloplasty

The proponents of stented pyeloplasty believe that it provides complete urinary diversion and decreases the risk of urinary leak. It also maintains ureteral calibre and anastamotic alignment. Others argue that an external stent increases the length of hospital stay and stents cause more urinary infection. Evidence suggests that stented and non stented repairs are equally successful(25).

There are two types of stents that can be used in pyeloplasty – internal stent eg, Double J stent or an external stent eg, transanastamotic nephrostomy/ pyelostomy stent. External stent usages has its putative complications which include stent blockage, dislodgement, bleeding and persistent urinary leak from the flank(25). The internal stent on the other hand may get blocked and more importantly when introducted antegradely may coil at the ureterovesival junction causing problems at removal. Chandrasekharam found that placing the stent by retrograde cystoscopy resulted in less malposition(26).

Minimally invasive versuss open pyeloplasty

In the paediatric population open pyeloplasty is the gold standard for PUJO repair with success rates up to 99%(27). Minimally invasive techniques like retrograde ureteroscopic endopyelotomy with the holmium:YAG laser(28) or ureteral cutting balloon catheter(29) have been tried but the failure and complication rates are unacceptably high.

Laparoscopic pyeloplasty provides the first viable minimally invasive alternative to repair PUJO(30). However few studies have compared the results of laparoscopic versus open pyeloplasty and the numbers are small. Barga et al compared three groups: laparoscopic pyeloplasty and open pyeloplasty done though a flank and dorsal lumbotomy incision. They found that laparoscopic pyeloplasty took significantly longer. This however may not hold true once more experience is gained in laparoscopy. Laparoscopic pyeloplasty is associated with decreased narcotic use and less pain compared to open procedures, thus contributing to a faster convalescence and earlier hospital discharge. They also found that the hospital stay was shorter for laparoscopic surgery than open. This shorter hospital stay could simply reflect a growing trend toward earlier discharge, which is effectively more pronounced for the more recently introduced method(31). Piaggio et al found that there is a higher rate of urinary leak in laparoscopic pyeloplasty(32). This is attributed to the difference in tissue handling and the suture materials used. A meta analysis conducted by Seixas-Mikelus et al revealed that the complication rates of laparoscopic pyeloplasty were double that of open pyeloplasty(33). Laparoscopy is a good option for older children but in infants open pyeloplasty is still the safe alternative.

The open pyeloplasty has evolved over time from using a large muscle cutting incision to using a muscle splitting incision less than 2.5 cm. This is comparable to the combined laparoscopy incision and narcotic requirement is minimal(31). Patient age, body habitus and surgeon experience are factors that may have a role in selecting patients who could potentially benefit from one technique over others.

Table 3.2 : Summary of the pros and cons of open and laparoscopic pyeloplasty.

Feature	Laparoscopic pyeloplasty	Open pyeloplasty
Cosmesis	Good	Comparable
Hospital stay	Shorter	Changing trend toward shorter
Narcotic usage	Less	More
Operating time	Longer	Shorter
Learning curve	Longer	Insignificant
Tissue handling	Bad	Good
Complications	More	Less
Optimal for	Older children, redo pyeloplasty	Infants

POSTOPERATIVE FOLLOW UP

Open dismembered pyeloplasty in children has reported success rates of up to 99%(27). Therefore the postoperative follow up of children after pyeloplasty, especially when the test involves exposure to ionizing radiation, has raised concerns.

What test to use?

The DRS is at present the most widely used tool to determine the outcome of pyeloplasty. The parameters of interest postoperatively are relief of obstruction and improvement in SRF. DRS is an invasive procedure and requires the use of ionizing radiation. Almodhen et al examined the use of ultrasound in the postoperative follow up and found that patients who show a downgrading of hydronephrosis in the postoperative scan might not require a DRS to rule out obstruction(34). Cost et al elegantly concluded form their experience that post pyeloplasty imaging should aim to identify those who require further intervention. They demonstrated that at- risk patients could be identified by a screening ultrasound and only selective patients needed to be subjected to a DRS. This will improve compliance and decrease cost and radiation exposure(2). Chipde et al went further to say that pelvic anteroposterior diameter, pelvic cortical ratio and pelvic urine protein-to-creatinine ratio are the most useful parameters to predict improvement in renal function after pyeloplasty(35).

<u>How long is long enough?</u>

Barga et al in their study compared retrograde endopyelotomy to redo pyeloplasty for failed pyeloplasty. They observed that recurrent obstruction can occur in the immediate postoperative period, soon after indwelling stent removal or several years later, raising questions about the timing, frequency and duration of follow up after pyeloplasty in children(27). Poosy et al in their long term follow up of pyeloplasty found that renal units that show an unobstructive curve one year post pyeloplasty never had problems on later DRS. These findings were corroborated by Pohl et al who stated that no follow up was required if the renogram done three months post operatively showed a unobstructed flow. However, renal units with half-times greater than 20 minutes and no functional loss may require longer follow up. Any obstructed system showing functional deterioration would require immediate intervention(36).

MATERIALS AND METHODS

STUDY DESIGN

This is a retrospective analysis of children who underwent Anderson Hynes pyeloplasty in the Department of Paediatric Surgery, Christian Medical College and Hospital, Vellore between January 2006 and December 2011.

PATIENTS

375 children underwent Anderson Hynes pyeloplasty between January 2006 and January 2011.

DATA COLLECTION

Patients undergoing pyeloplasty were identified by a list generated in the pathology department of the specimens of PUJ sent for biopsy.

The operative records, investigations and follow up data were collected from the hospital records and reviewed. The data was collected in the following categories and will be further analysed as such:

1. Demographic information and clinical parameters

2. Functional parameter as in split renal function and drainage by radionucleotide scan

175(52%) children had pre and postoperative radionuclide scan data available. Only children with unilateral PUJO were included in this analysis.

Two parameters were analysed

(**a**) split renal function documented as a numerical value in the report

(**b**) drainage curve in the renogram reported as poor function, partial obstruction, obstruction, slow drainage and patent drainage.

Exclusion criteria

Bilateral PUJO

Solitary kidney

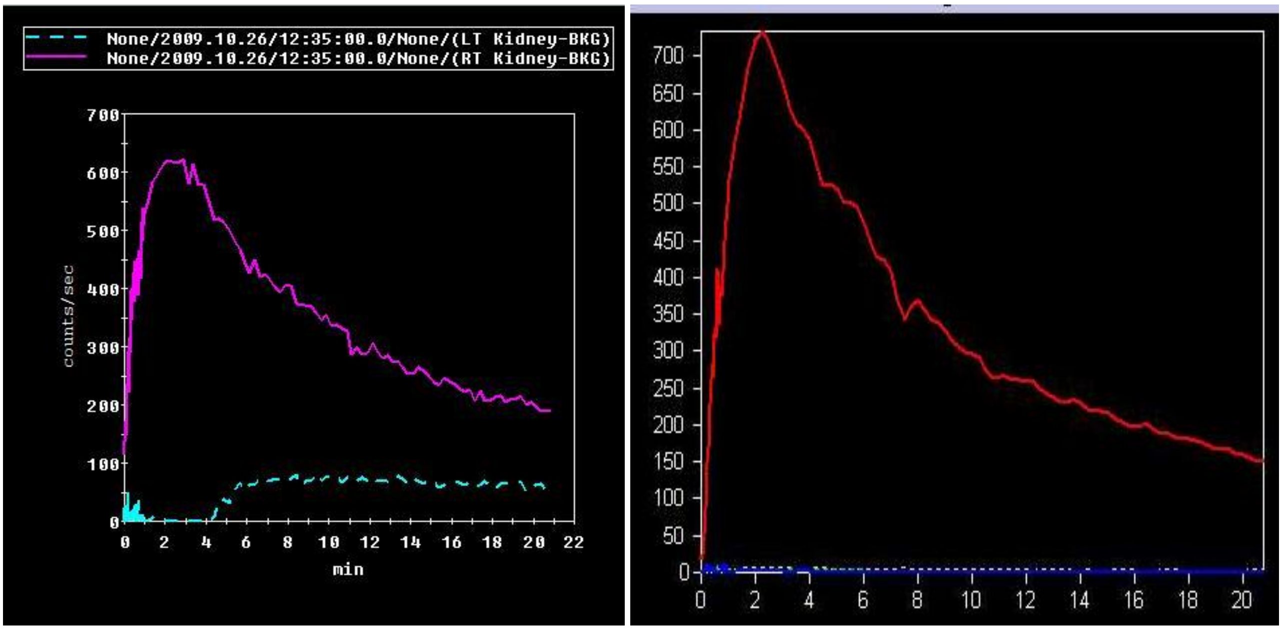


Figure 4.1: pre and postoperative renogram of a child with very poor functioning kidney which did not show improvement postoperatively

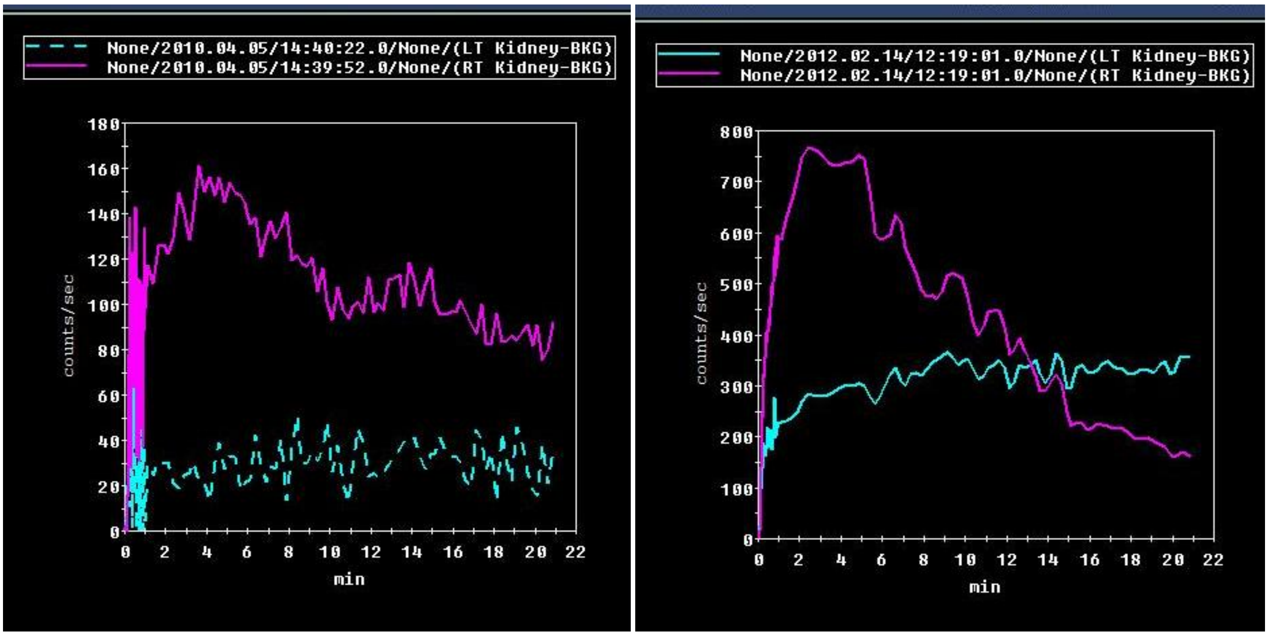


Figure 4.2: pre and postoperative renogram of a child with persistent obstruction after pyeloplasty with some improvement in function.

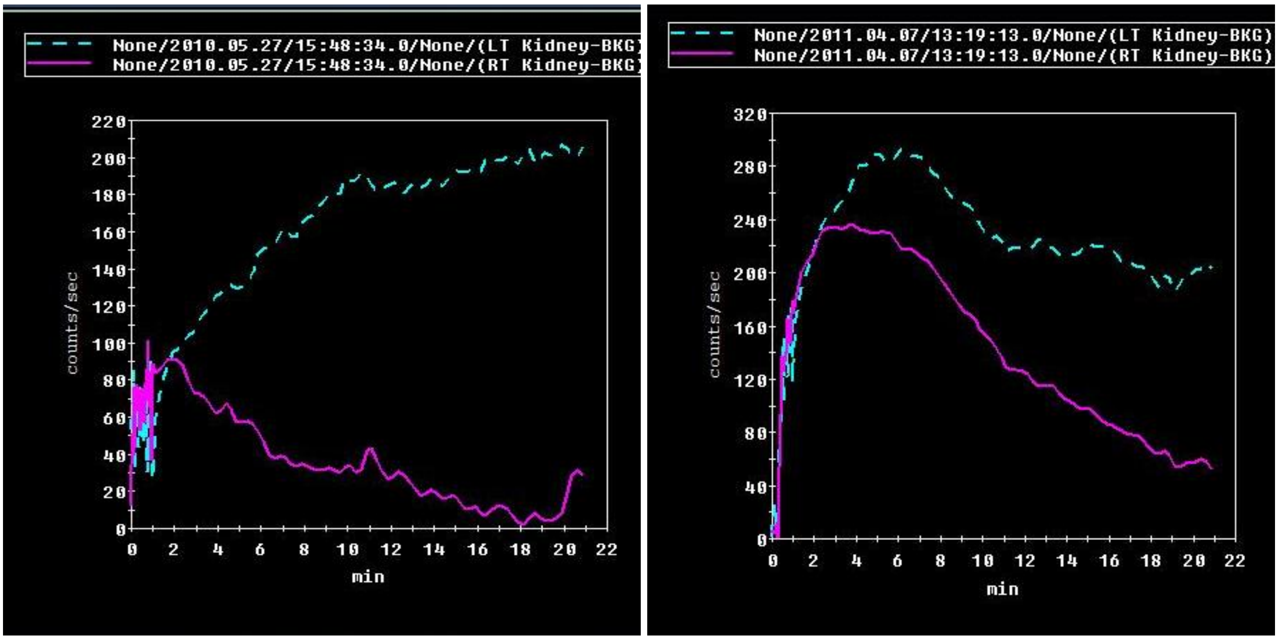


Figure 4.3: pre and postoperative renogram of a child showing slow patent drainage postoperative

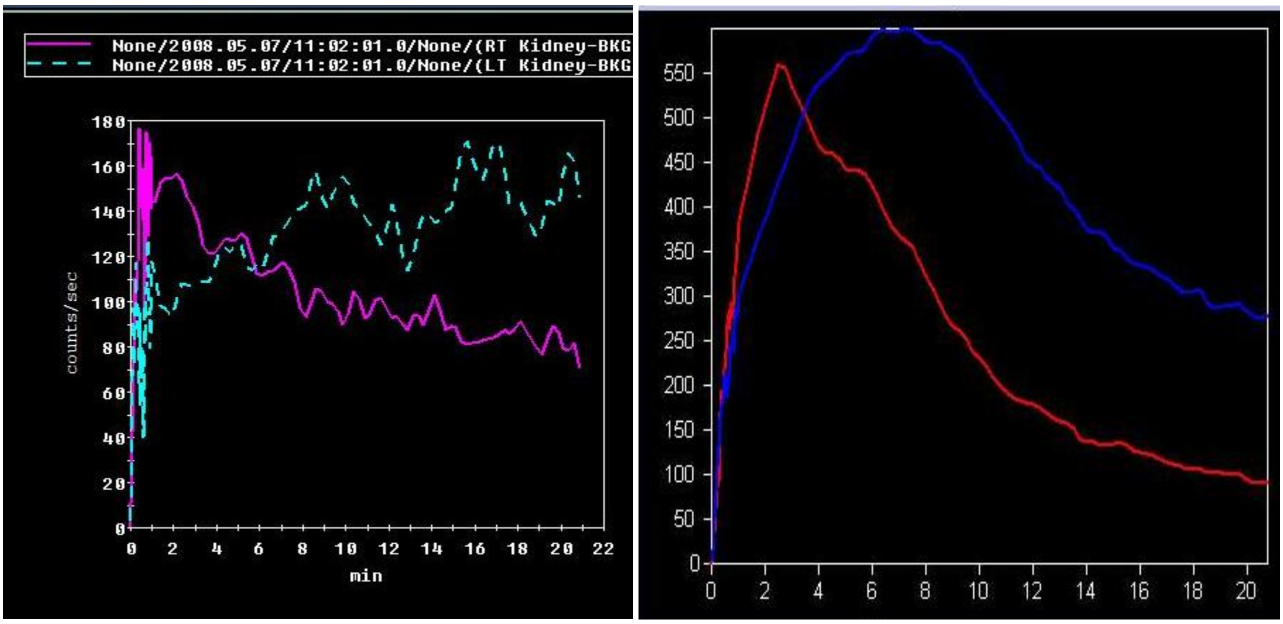


Figure 4.4: pre and postoperative renogram of a child showing patent drainage postoperatively.

3. Radiographic parameter as indicated by pre and post operative anterioposterior (AP) diameter by renal ultrasound.

151 renal units had both pre and post operative documentation of anteroposterior(AP) diameter. 245 had preoperative scan with AP diameter documentation and 201 had post operative documentation of the same. Bilateral disease was considered as two individual renal units for analysis.

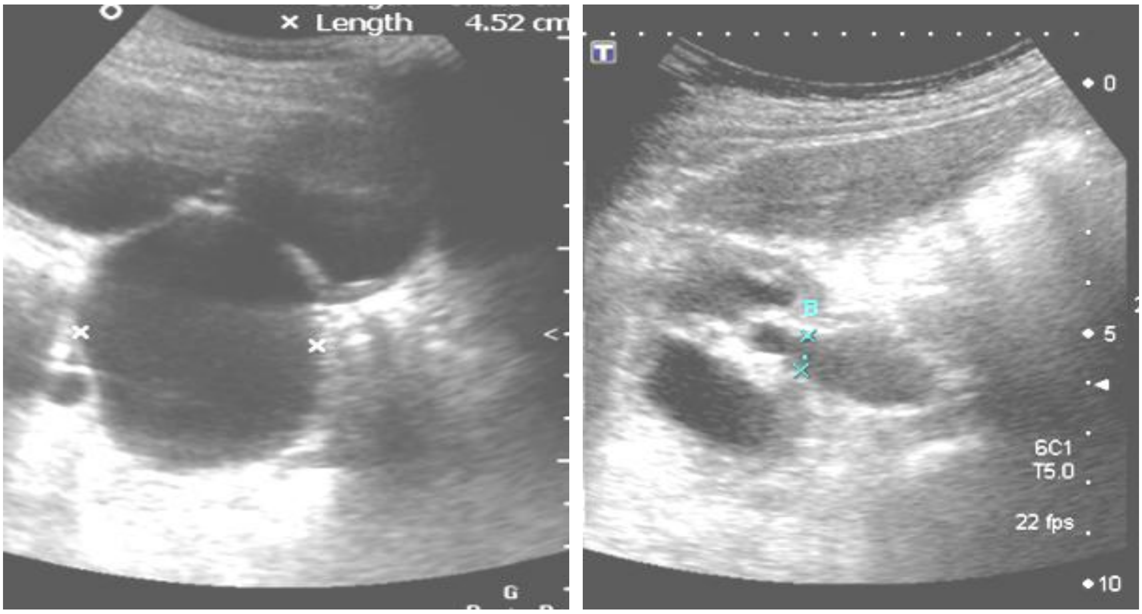


Figure 4.5: pre and postoperative US showing the reduction in the AP diameter and hydronephrosis(4.5cm to 0.7cm)

4. Failed pyeloplasty

5. Other procedures

RESULTS

1.DEMOGRAPHIC INFORMATION

A. Number of operations performed every year

The number of operations being performed every year has been steadily increasing. This could be attributed to the increasing numbers of children being diagnosed antenatally. However, number of children who were diagnosed antenatally and operated is declining in the last couple of years due to a global trend toward watch and wait rather than early operation.

Table 5.1.1: Number of operations performed every year

Year	Number of patients	Antenatal detection and operation
2011	86	8
2010	76	14
2009	77	18
2008	68	11
2007	35	7
2006	33	9

B. Sex:

62(16.2%) girls and 313(83.8%) boys underwent the operation in the study period.

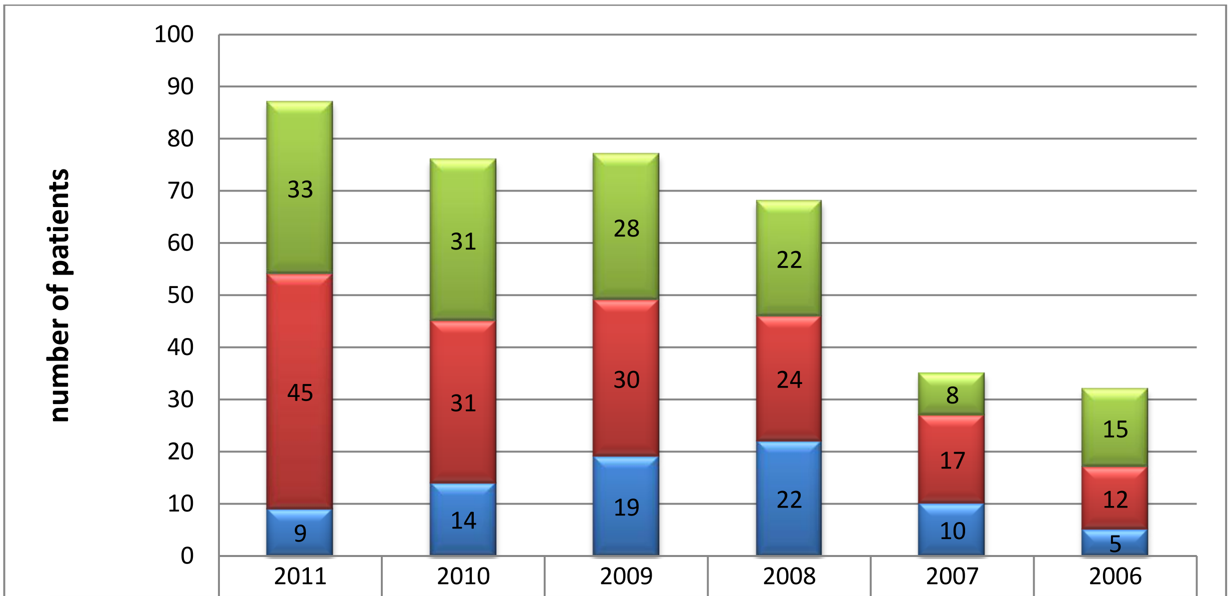
C. Table 5.1.2: Side of the affected renal moiety(n=375)

Side affected	**s**	**Percentage (%)**
Left	241	64.2
Right	96	25.6
Bilateral	34	9.06
Left solitary	3	0.80
Right solitary	1	0.26

D. Age at operation:

The age at operation ranged from 4 days to 15 years of age (mean 3.8 years, median 3 years). The average age at operation has shown an upward trend and fewer children are being operated before one year of age as demonstrated in the figure below.

Figure 5.1.1: Distribution of age at operation over 6 years.



	2011	2010	2009	2008	2007	2006
>5 years	33	31	28	22	8	15
1 to 5 years	45	31	30	24	17	12
<1 year	9	14	19	22	10	5

E. Presentation:

68 children were antenatally detected to have hydronephrosis of whom 3 had a palpable mass, 1 had abdominal distension and 3 developed a urinary infection postnatally. 35 children were incidentally found to have PUJO when being evaluated of unrelated symptoms. The symptomatology of the remaining 281 children is summarised below in Table 5.1.3

Table 5.1.3: Presenting symptoms (n=281)

Symptom	Number	Percentage (%)
Pain	131	46.6
Urinary tract infection	68	24.1
Palpable mass	60	21.3
Pyonephrosis	10	3.5
Hematuria	8	2.8
Vomiting	2	0.7
Urinary ascitis	1	0.3

F. Length of hospital stay

The average hospital stay is 5.8 days (range 1 day to 23 days). The average hospital stay for the 72 patients who had a internal DJ stent was 4.5days (SD 2.4) compared to the 268 children with external stents which was 6.2days (SD 3.2). The difference between these two groups was statistically significant (P value <0.0001).

G. Associated anomalies:

Table 5.1.4 summarises the associated anomalies/ conditions found in 60 of 377 patients .

Table 5.1..3: Associated anomalies

Associated ipsilateral anomaly	**Number of patients**
Crossing vessel	10
Duplex	9
VUR (ipsilateral)	2
VUJ obstruction	4
VUJ obstruction with multiple ureteric stenosis	1
Solitary	4
Horseshoe kidney	3
High insertion of ureter	3
Renal calculus	1
Other genitourinary anomalies	
Crossed fused ectopia/ Ectopic kidney	3
Undescended testis	2
Bilateral VUR	5
Posterior uretheral valve	2
Y duplication of urethra	1
Wilms tumour on opposite side	1
Nephrotic syndrome	1
Undescended testis	1
Contralateral MCDK	1
Other system anomalies	
Malrotation of gut	2
Hemihypertrophy	1
Hernia / hydrocoele	3

Figure 5.1.2: MCU showing major VUR causing kinking at the PUJ

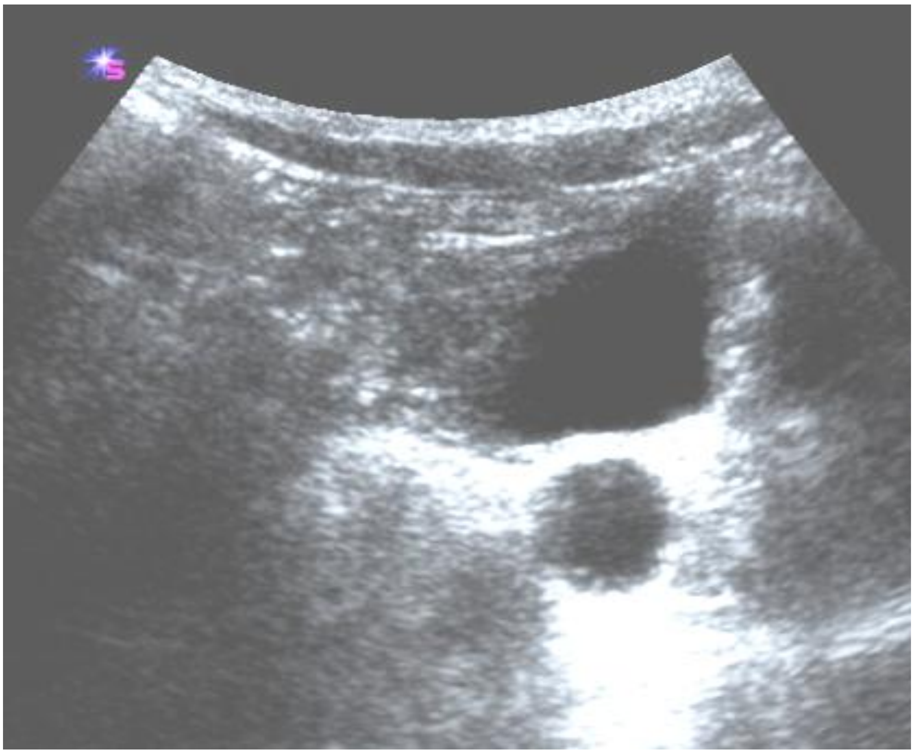


Figure 5.1.3.a and b: US showing the dilated ureter and renal pelvis in a child with PUJO and VUJO

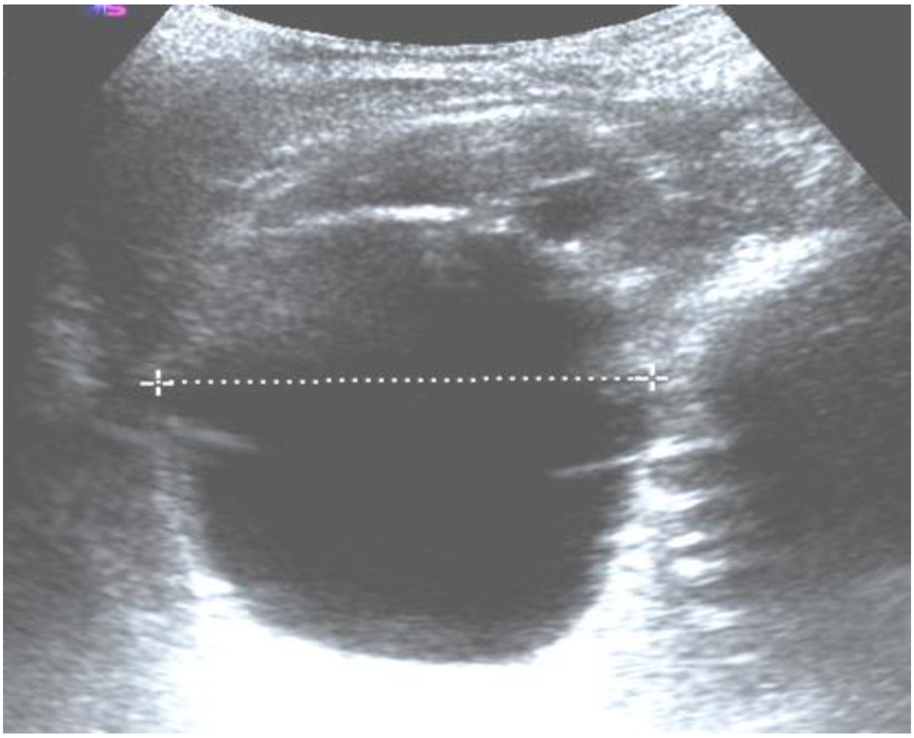
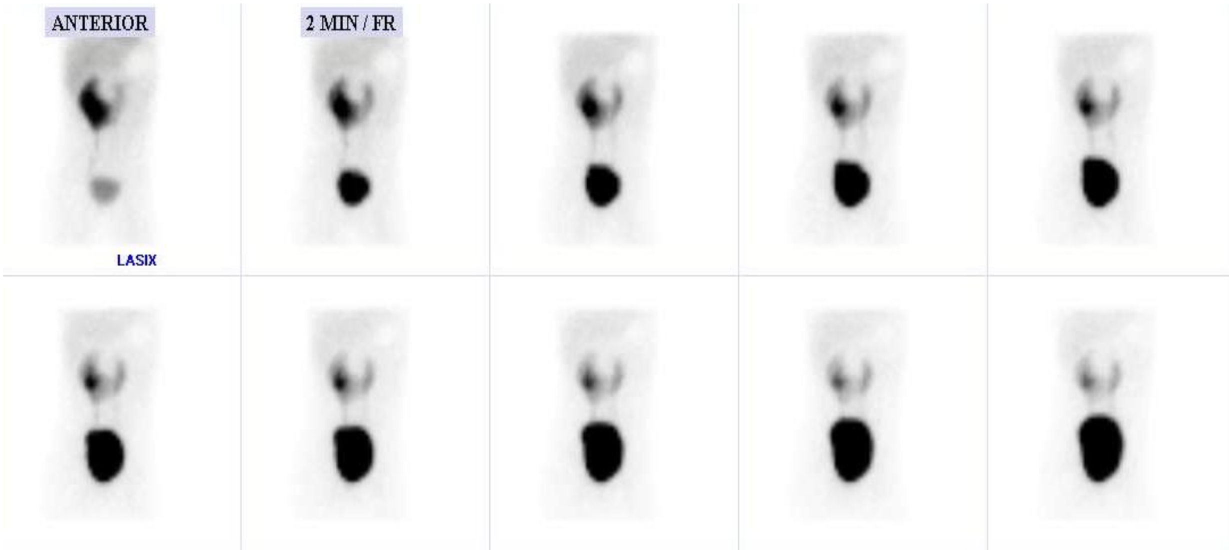


Figure 5.1.4: Radionuclide scan of a horseshoe kidney



The scan shows a horseshoe kidney with poorly functioning obstructed left renal moiety with a normal right moiety.

2. RESULTS OF PYELOPLASTY

Overall results

Of the 375 children who underwent Anderson Hynes pyeloplasty between January 2006 and January 2011,359 children had successful surgery as inferred by resolution of symptoms.

Immediate postoperative readmission

Twenty one children had to be admitted postoperatively, the reasons are summarised below

Table 5.2.1 Post operative readmissions

Postoperative complication	Number of patients
Urinary tract infection	13
Urine leak	4
Pyonephrosis	3
Hematuria	1

Failed pyeloplasty

Of 375 children 16 had failed pyeloplasties. 11 of these children had salvageable kidney function and they underwent redo pyelpolasty, the other 5 had nephrectomy.

- ***Redo pyeloplasty***

The average preoperative split renal function of these 11 kidneys was 47.5% (range 31% to 65%). The median age at first surgery was 11 months (range 1 to 156 months). It is interesting to note that 7 of the 11 children requiring redo surgery were less that 1 year old at the first operation. Lim et al found a similar association and have quoted Snyder et al to have found the same(37). The redo operation had to be performed at an median of 12 months (range 1 to 72 months) after the first operation. In the interim period 6 children required a percutaneous nephrostomy for increasing hydronephrosis or pyonephrosis, one child who was operated outside had a DJ stent inserted before referral for further treatment. One child had reexploration of the PUJ with an antegrade pyelogram and release of surrounding fibrosis. He however continued to have symptoms and had a redo 2 years later.

9 children had redo Anderson Hynes pyeloplasty(1 laparoscopic and 8 open), one child had reexploration of the PUJ and DJ stent placement initially and later a redo pyeloplasty and one child had an appendicular replacement of ureter. After redopyeloplasty the average function was 45.4%(n=5) (range 9% to 75%).

Table 5.2.2.a: reasons for reoperation(n=11)

Reason for reoperation	Number of children
Increasing hydronepjrosis	6
Pyonephrosis / recurrent UTI	4
Renal failure with obstruction in a solitary kidney	1

Table 5.2.2.b: Type of redo operation

Type of operation	Number of patients
Open redo pyeloplasty	8
Laparoscopic redo pyeloplasty	1
Exploration of PUJ followed by redo pyeloplasty	1
Appendicular replacement of ureter	1

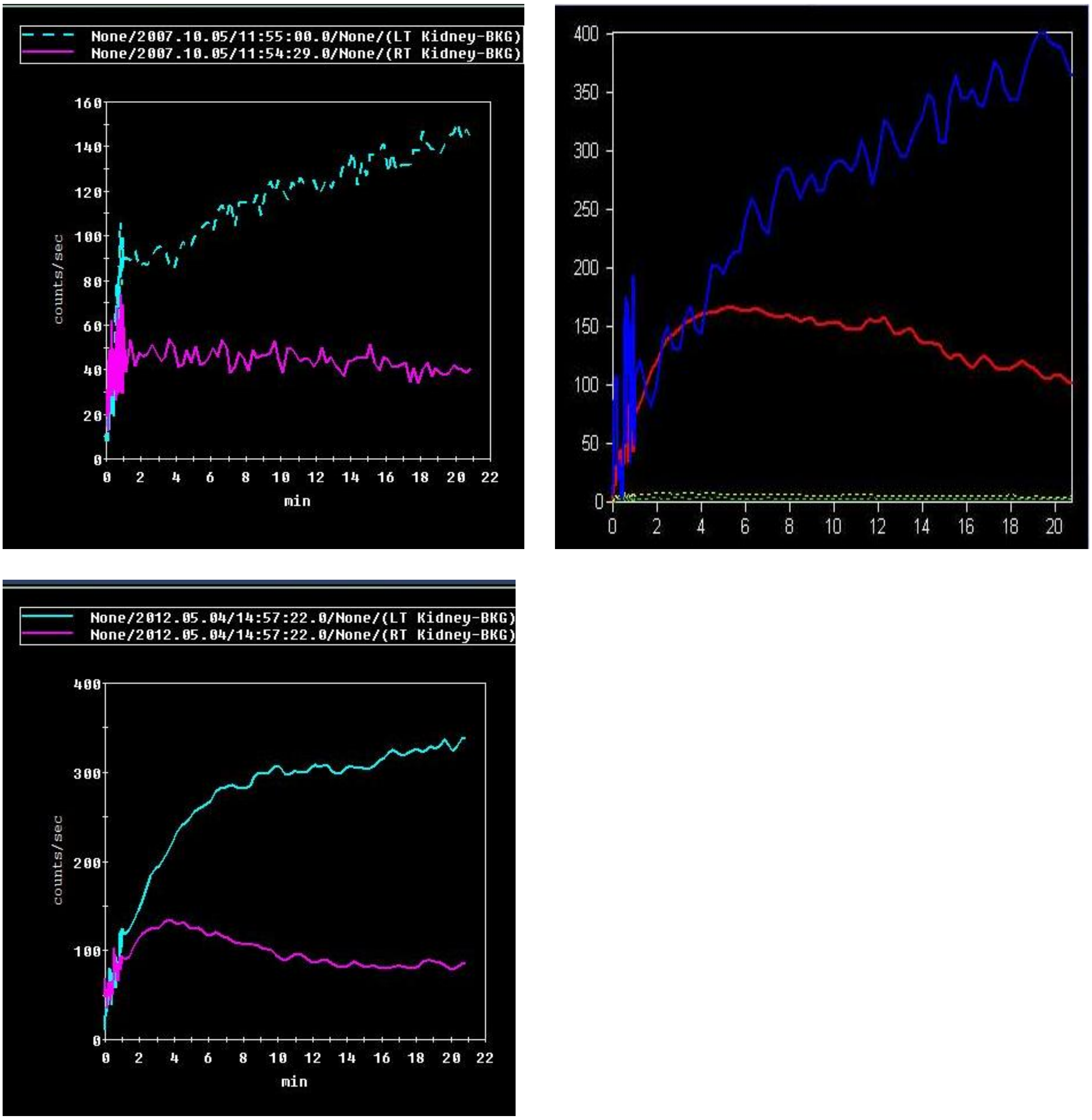


Figure 5.2.1: renograms of a child who had redo pyeloplasty due to a persistent obstructed curve postpyeloplasty and recurrent UTI. The post redo scan shows improvement in drainage.

- ***Nephrectomy***

Five children had a nephrectomy after pyeloplasty. The prepyeloplasty split renal function in these children ranged from 8% to 10%.

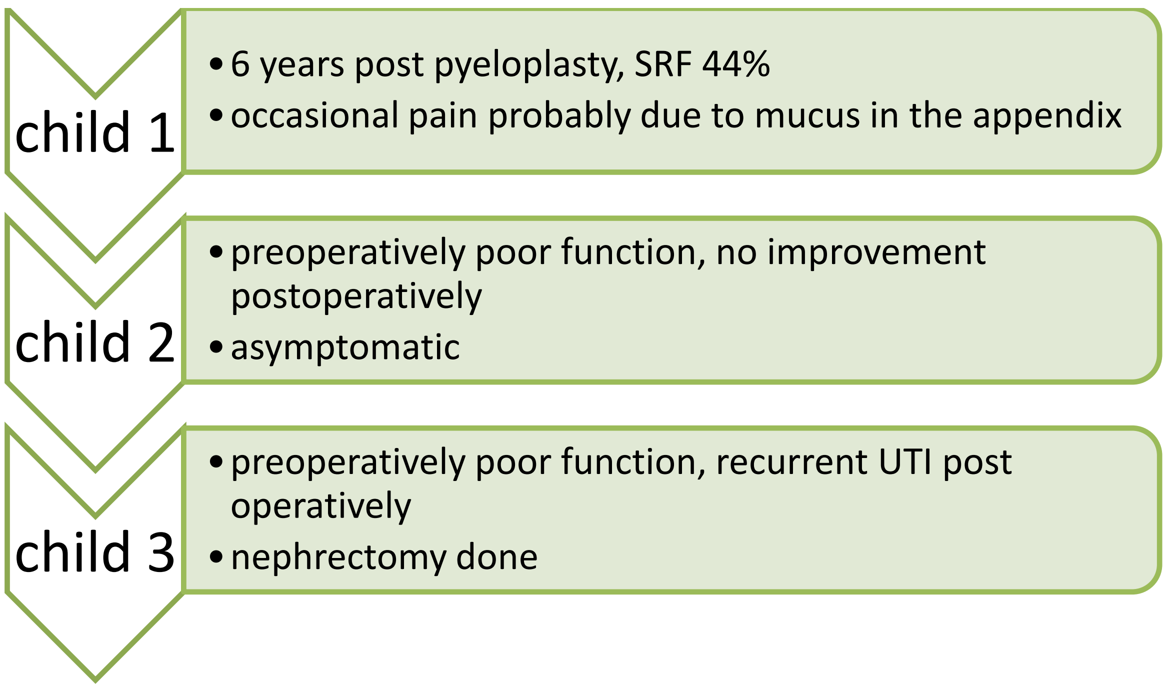
Table 5.2.3: Patient profile pre and post pyeloplasty

Prepyeloplasty profile	**Postpyeloplasty profile**
Ectopic kidney with poor function and hematuria	No improvement in function
Ruptured hydronephrotic kidney, Appendicular replacement	UTI with poor function
Pyonephrosis	UTI with poor function
Poor function	Pyonephrosis
Poor function	No improvement in function

Appendicular replacements

Three children underwent this novel alternative method which replaces an unhealthy ureter with the appendix. One child is doing well six years post appendicular replacement of ureter with a split renal function of 44%. One child had a poorly functioning kidney preoperatively and the function has not improved but she is asymptomatic. The third child with a poorly functioning kidney preoperatively, developed recurrent urinary infections post appendicular replacement of ureter and had a nephrectomy.

Figure 5.2.2: pre and postoperative profile of children who had appendicular replacement.



3. ANALYSIS OF RADIONUCLEIDE SCINTIGRAPHY RESULTS

(a) <u>SPLIT RENAL FUNCTION</u>

Pre and post pyeloplasty differential functions

Complete pre and postoperative data was available for 175 (52%) of children with unilateral PUJO.

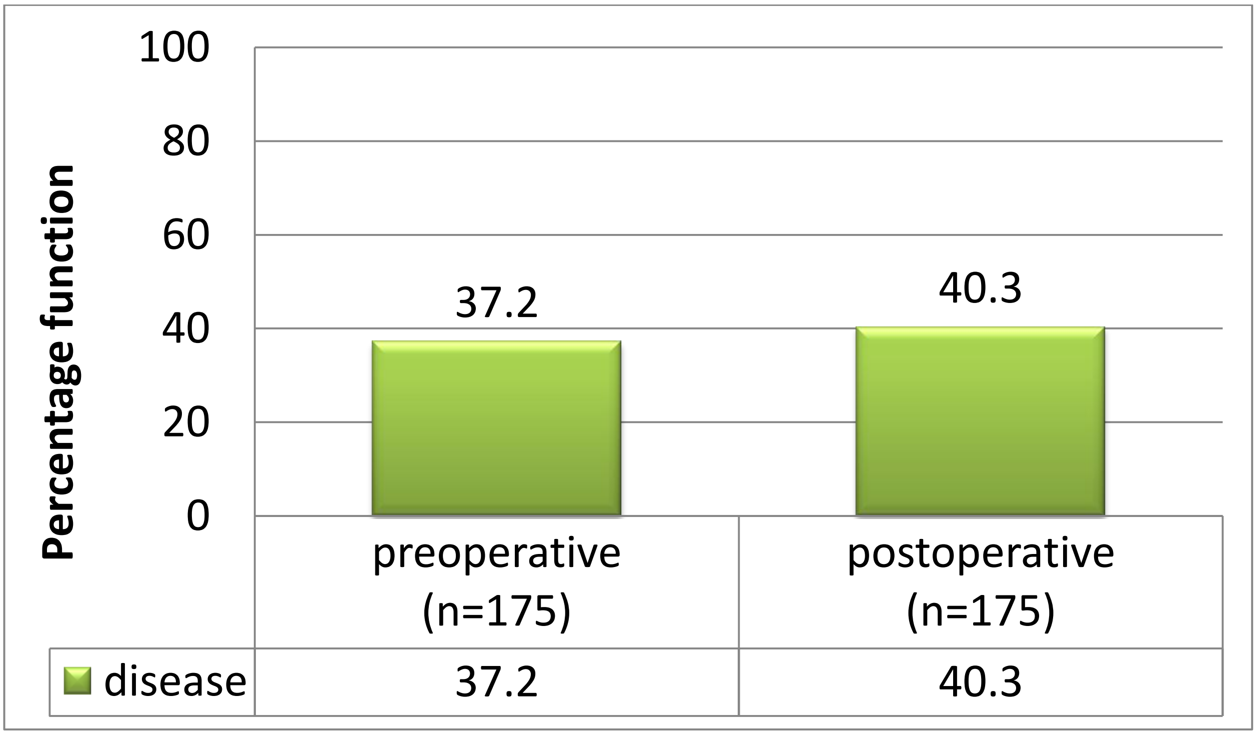


Figure 5.3.1: Pre and post pyeloplasty differential functions

The average preoperative differential renal function was 37.2%. It increased to 40.3% on the postoperative scan. The percentage difference between the two values is 3.1% which is not statistically significant (p value = 0.48). There is however an 8.5% improvement in function over the pre operative value.

Antenatally detected versus symptomatic

47 children were detected on antenatal scan to have hydronephrosis due to PUJO. The average age at operation for these children was 17 months. 129 children presented with the various symptoms described in Table 4.1. The radionucleide scans of these two groups were compared.

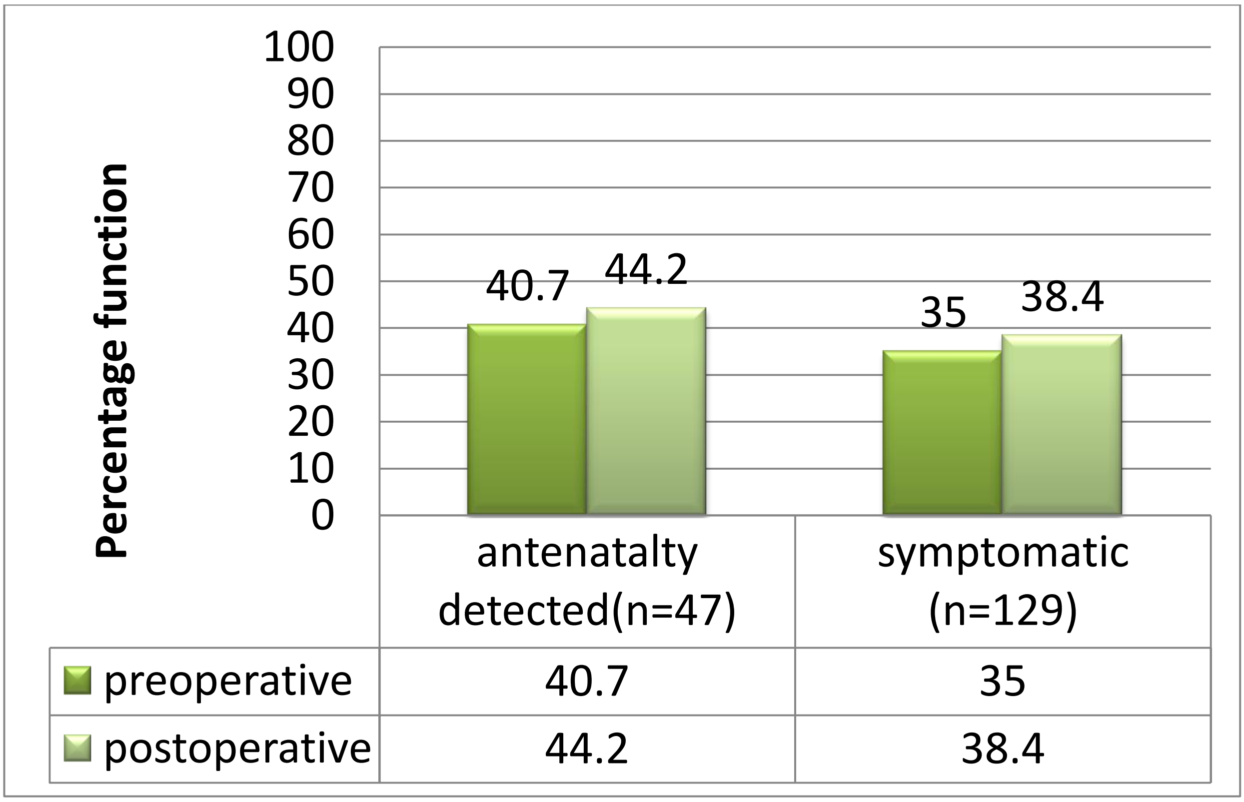


Figure 5.3.2: Antenatally detected versus symptomatic

Kidneys with antenatally detected PUJO were slightly better preserved preoperatively than the children who were detected when symptoms developed (40.7% versus 35%). This reflects in the post operative percentage function as well (44.2% versus 38.4%). The percentage difference between the two variables is not statistically significant (p value = 0.48). The percentage increase in function over the preoperative value in the two groups was 8.5% and 10.3% respectively.

Supranormal functioning kidneys

31 kidneys showed more than 50 percent function (supra normal function). The post operative function in these children showed a decrease in function (54.4% versus 53%). This decrease in function is expected as the drainage improves. The p value of this comparison was 0.80 which was not significant.

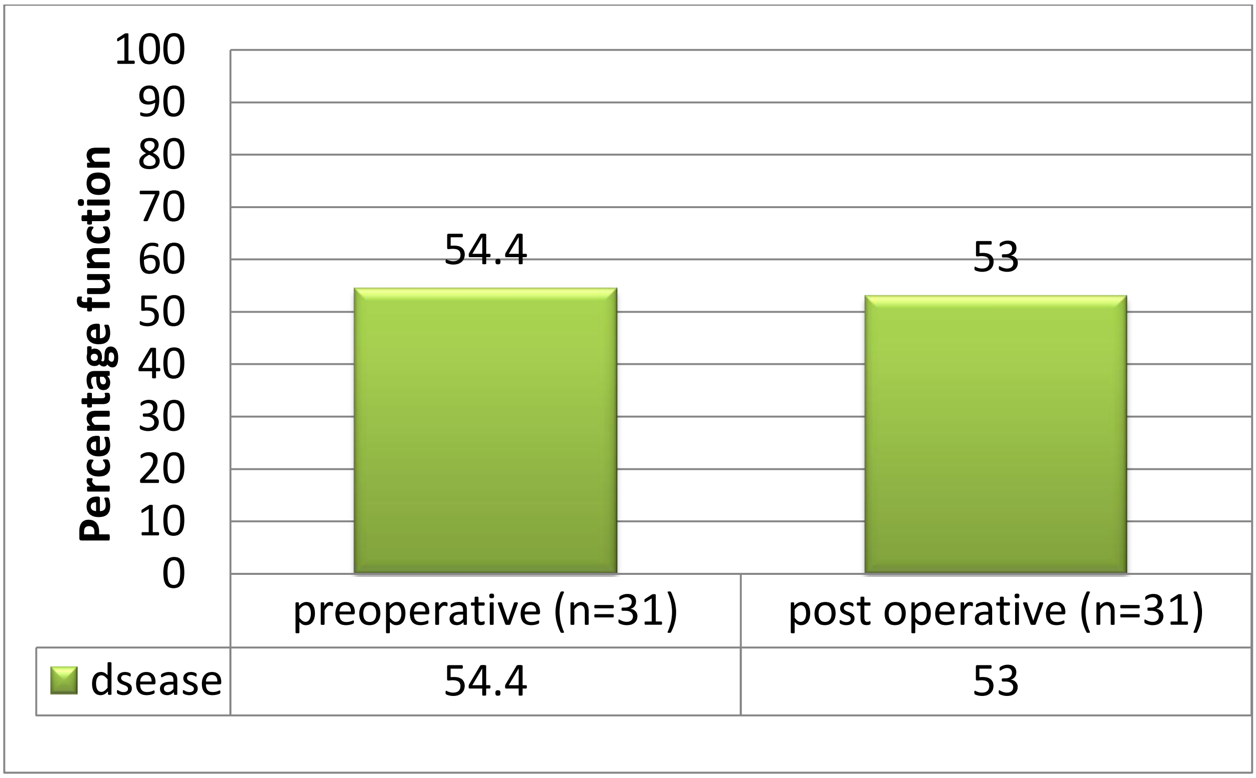


Figure 5.3.3: Supranormal functioning kidneys

DJ stent versus external stent

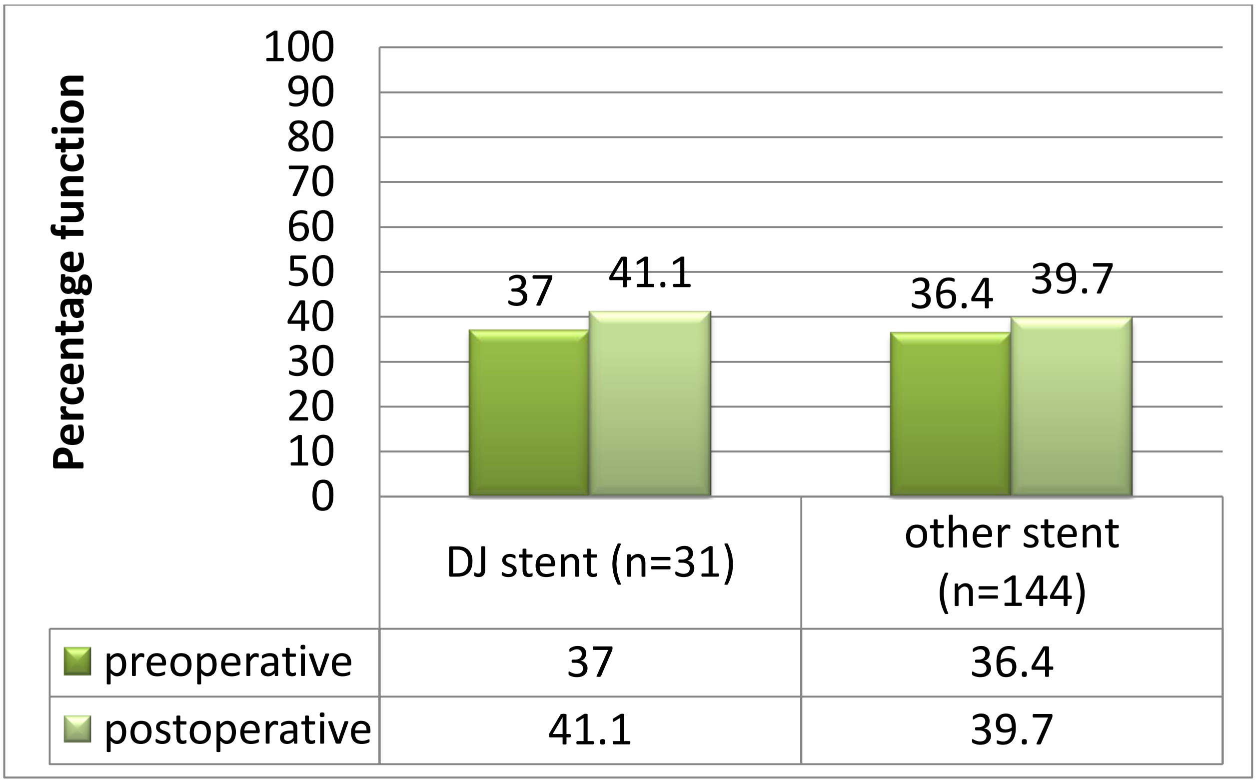


Figure 5.3.4: DJ stent versus external stent

31 patients had a Double J stent placement across the anastamosis. This stent is removed cystoscopically 6 to 8 weeks after insertion (internal stent). The remaining 144 patients either did not have a stent placed or had an external stent in the form of a nephrostomy and transanastamotic stent which is removed 3 to 5 days post operatively.

The percentage increase in function between pre and postoperative values was marginally better in the DJ stent group (4.1% versus 3.3%). The percentage improvement over the preoperative value in the two groups was 15% in the DJ stent group and 9.3% in the other stent group. These values were not significant statistically with a p value of 0.81.

Laparoscopy versus open operation

5 children underwent laparoscopic pyeloplasty. DRS data was avalible for 4 of the 5 patients.

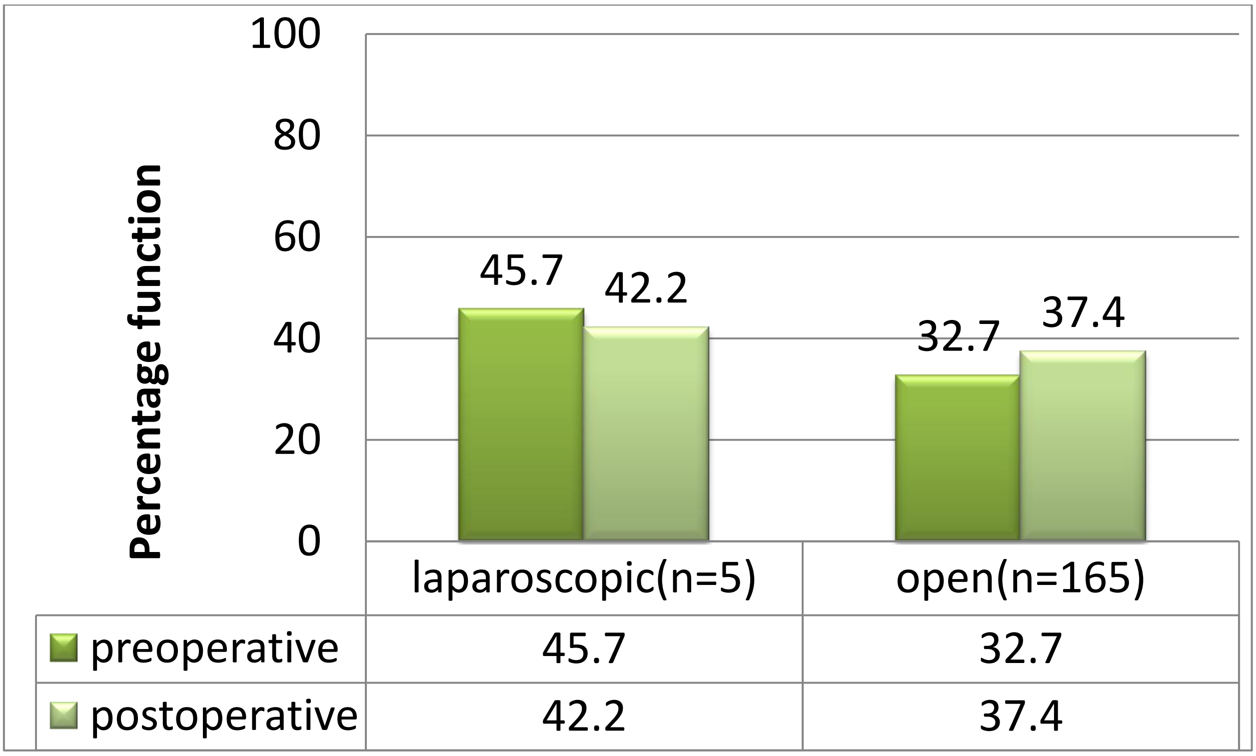
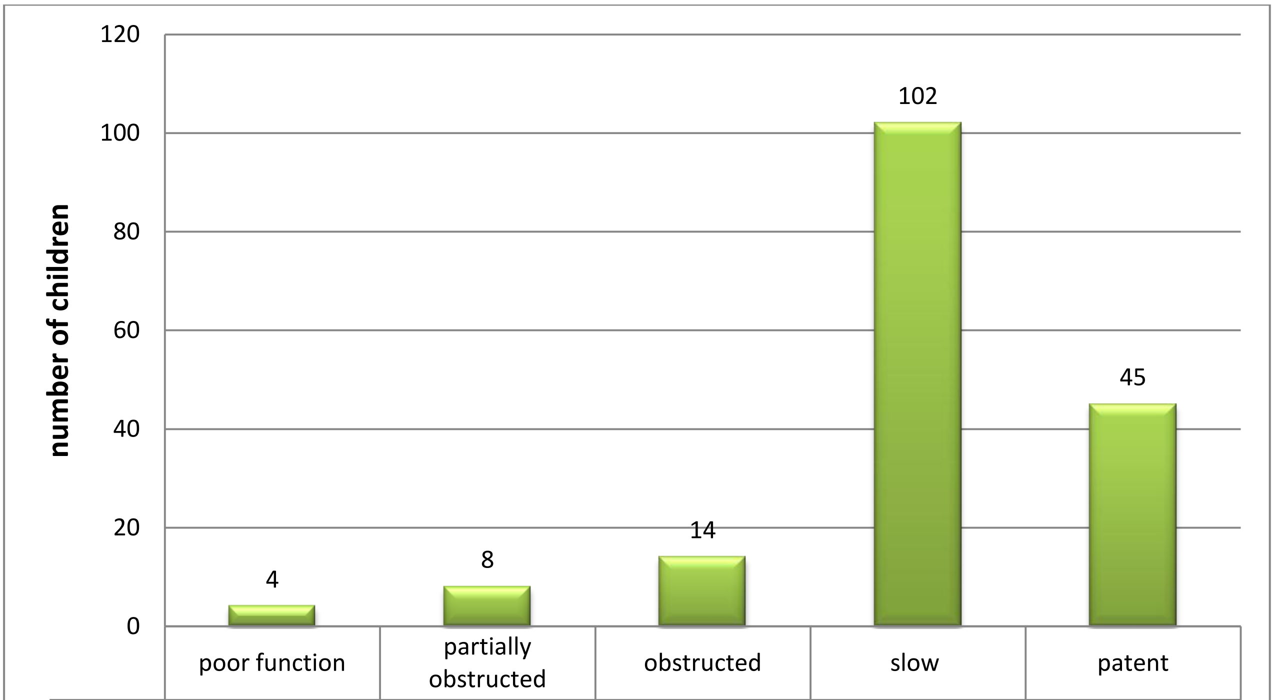


Figure 5.3.5: Laparoscopy versus open operation

The overall function seems to have decreased in the laparoscopic group. This is attributed to the fact that 2 patients had supranormal function preoperatively which decreased on follow up. The numbers however are too small to make a meaningful comparison between the two groups.

B. DRAINAGE PATTERN

The DRS was reported by doctors from the Department of Neuclear Medicine. 175 children had obstructed drainage preoperatively. After pyeloplasty the drainage has improved in 147 children (102 slow patent drainage, 45 patent drainage). 4 children had extremely poor function in whom the drainage could not be assessed. Of the remaining 22 children 8 had partial obstruction to drainage and 14 did not show any improvement in the drainage curve.



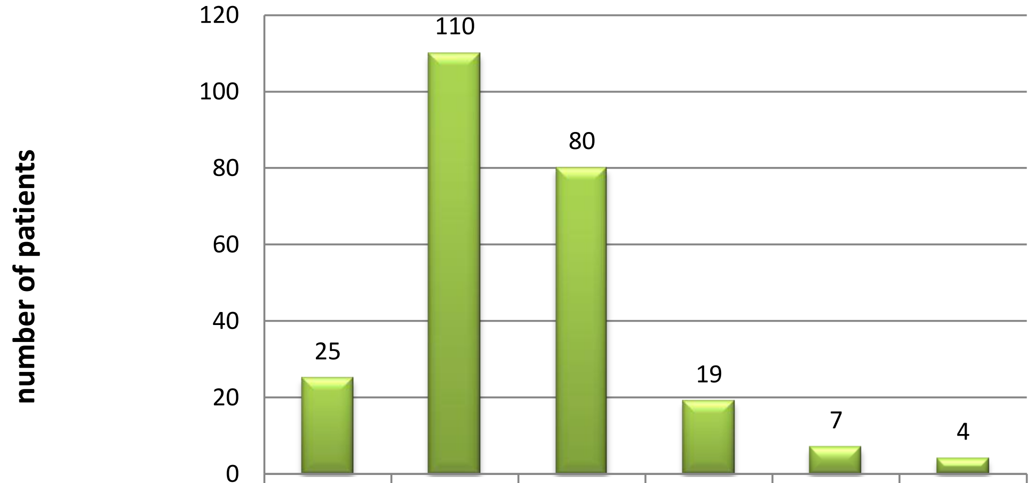
	poor function	partially obstructed	obstructed	slow	patent
Series1	4	8	14	102	45

Figure 5.3.6: Renogram curve(n=175)

4.ANALYSIS OF ULTRASONOGRAPHY RESULTS

Preoperative AP diameter

245 children had a pre operative record of the anterioposterior (AP) diameter of the renal pelvis. The average AP diameter was 4.1cm (range 0.9cm to 13.1). The AP diameter for most children ranged from 2 to 4 cm(n=110) followed closely by 4 to 6cm(n=80).

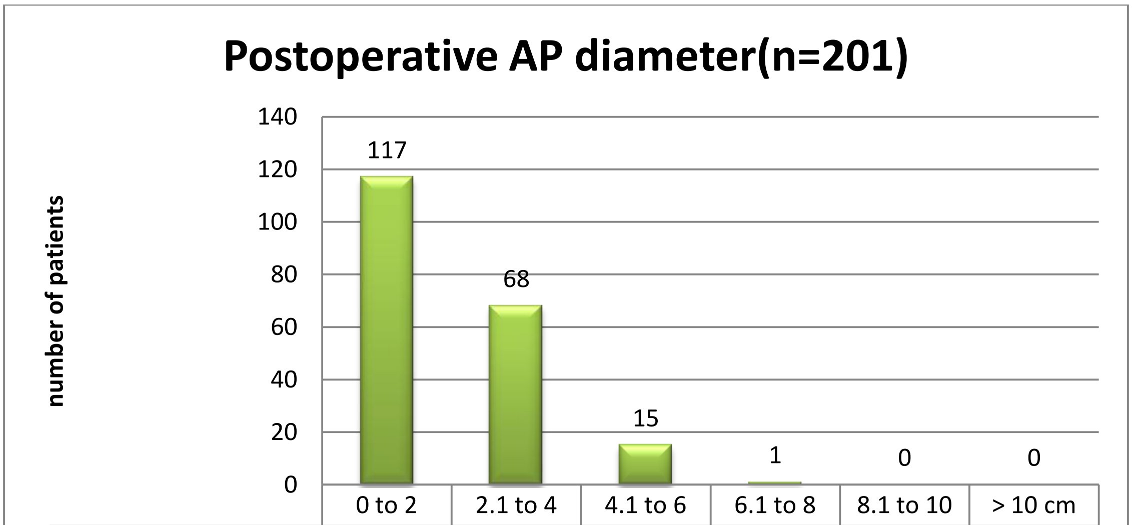


	0 to 2	2.1 to 4	4.1 to 6	6.1 to 8	8.1 to 10	> 10 cm
preoperative(n=245)	25	110	80	19	7	4

Figure 5.4.1: Preoperative AP diameter (n=245)

Postperative AP diameter

201 patients had a post operative measure of AP diameter and the average was 2.1cm (range 0.3cm to 6.8cm). The postoperative pattern is different as in most of the AP diameters are less than 2cm(n=117). There is a significant reduction in AP diameter.



	0 to 2	2.1 to 4	4.1 to 6	6.1 to 8	8.1 to 10	> 10 cm
postoperative(n=201)	117	68	15	1	0	0

Figure 5.4.2: Postperative AP diameter

Comparison of pre and postoperative AP diameter (n=150)

150 children had both pre and postoperative AP diameters. The mean pre operative value was 4.08cm which decreased to 1.96cm. The difference was statistically significant with a p value of <0.0001.

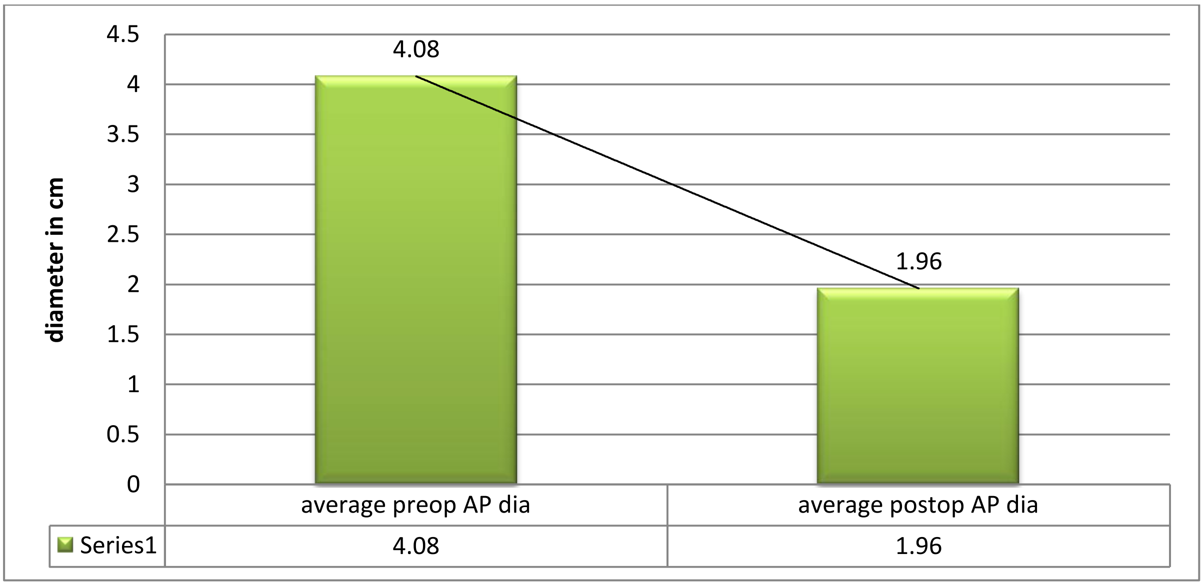


Figure 5.4.3: Comparison of pre and postoperative AP diameter (n=150)

DISCUSSION

PUJO is the most common congenital urinary obstruction. The surgical correction of PUJO is probably one of the commonest urological operations performed by the Paediatric Surgeon. Open pyeloplasty is the gold standard in the management of paediatric PUJO and has documented success rates upto 99%.

LENGTH OF HOSPITAL STAY

375 pyeloplasties were performed between 2006 and 2011, with an overall success rate of 96.3%. The number of operations has steadily increased over the study period as shown in the table below. The length of hospital stay has decreased from 6.9 days(SD 4.4) in 2006 to 4.8(SD 2.4) days in 2011. **The difference is statistically significant with a p value of 0.009**. This trend is consistent with the findings of Nelson et al who found a statistically significant decreased in length of stay from 6.7 days (1988 to 1991) to 3.7 days (1997 to 2000, p <0.0001)(3). This could be attributed to the use of Double J stents in recent years compared to the external stent used earlier. Also there is a global trend toward earlier discharge which is reflected here.

Figure 6.1: Length of hospital stay

Year	**Number of patients**	**Length of stay(days)**	**Median(days)**
2011	86	4.8	4
2010	76	5.6	5
2009	77	5.6	6
2008	68	6.6	6
2007	35	6.9	6
2006	33	6.9	6

AGE AT OPERATION

The age at operation has seen an upward trend with 10.4% children below one year being operated in 2011 compared to 32.3% children in 2007. Nelson et al found a similar trend in which the proportion of procedures done during the first 6 months of life has shown a significant decrease from 34.2% (1988 to 1991) to 25.2% (1997 to 2000, p _0.0001).This trend which has evolved worldwide reflects the change from early operation to watchful waiting(3, 6)

PRESENTATION

The mode of presentation in our patients was different from the published literature. The trend worldwide is toward antenatal detection whereas only 18% of our patients were detected as. The majority of antenatally detected children are on followup and may not need surgery.

ASSOCIATED ANOMALIES

Vesicoureteric reflux

The incidence of urological anomalies associated with PUJO was 15.4% compared to 20% quoted by Karnak(38). Seven children (1.8% of total, 11% of anomalies) had VUR – 5 bilateral, 1 ipsilateral and 1 in a solitary kidney. Bomalaski et al found an incidence of 0.6% concummitent VUR in their series(39). We do not do a routine MCU for all children with PUJO. A MCU is undertaken if the child has UTI with hydronephrosis, has ureteric dilatation or has bilateral hydronephrosis. The low incidence found in the report by Bomalaski et al justifies this strategy. All seven children initially presented with UTI. Hollowell et al classified concumittent PUJO with VUR into 3 categories(40). Group 1 had primary PUJO with incidental minor reflux, Group 2 had PUJO secondary to major reflux and kinking and Group 3 had pseudo PUJO with dilated upper tracts that do not show obstruction on the renal scan. Of the seven, 4 had major reflux, of whom 3 were causing a significant kink at the PUJ. Two children had minor reflux which was detected after the pyeloplasty. One had a MCU outside and the degree of reflux was not known. One child underwent a reimplant for bilateral major reflux and on follow up scans the degree of hydronephrosis on one side progressively worsened. Further investigation revealed a PUJO obstruction on that side. Alizadeh et al similarly reported two cases of major reflux in which the presence of PUJO can be missed(41).

Vesicoureteric junction obstruction

Obstruction at the PUJ and VUJ was found to coexist in 5(1.3% of total) children, one had a solitary kidney. The diagnosis is difficult because severe obstruction at one end of the ureter may mask the one at the other end. 2 children were diagnosed preoperatively and 1 during pyeloplasty was found to have a dilated ureter. Two children were found to have obstructing hydronephrosis on postoperative follow up; one after pyeloplasty and one after surgery for bilateral VUJO. The routine use of a retrograde pyelogram could avoid pyeloplasty failure in these instances and has been advocated by Moodley et al(42).

Duplex ureter

Figure 6.1: US of a duplex renal moiety showing differential hydronephrosis

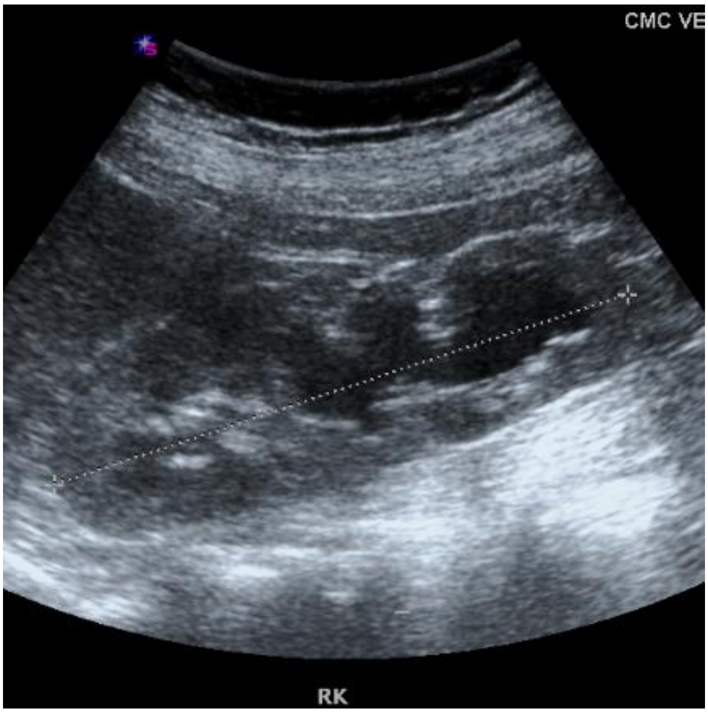


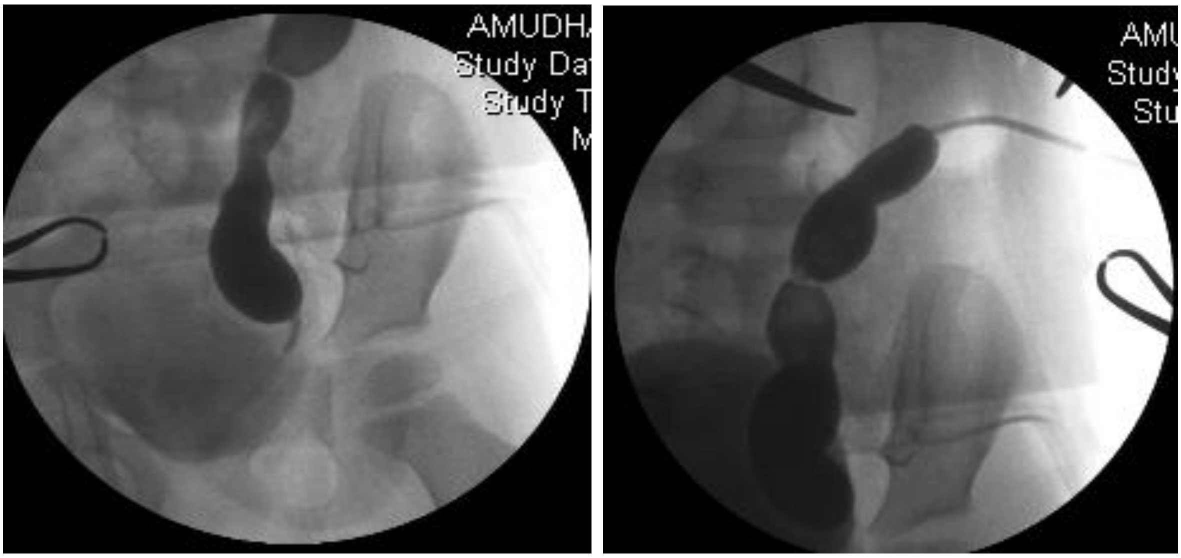
Table 6.2: 8 children with obstruction in a duplex system

Pt	Age	Sex	Presentation	Type	Operation
1	1	M	Antenatally detected	Incomplete lower pole	Lower pole pyeloplasty
2	4	F	Incidental	Incomplete lower pole	Lower pole pyeloplasty
3	6	M	UTI	Incomplete lower pole	Lower pole pyeloplasty
4	9	M	UTI	Complete lower pole	Lower pole pyeloplasty
5	<1	M	Antenatally detected	Incomplete lower pole	Lower pole pyeloplasty
6	3	M	Pain	Incomplete lower pole	Lower pole pyeloplasty
7	4	F	Pain	Incomplete lower pole with crossing vessel	Upper and lower pole ureteropyelostomy
8	1	M	Mass	Incomplete lower pole	Upper and lower pole ureteropyelostomy
9	<1	M	Antenatally detected	Incomplete lower pole	Lower pole end to side ureteropyelostoly

8 children did well postoperatively and are asymptomatic. One child had recurrent UTI and was planned for a redo pyeloplasty but had improving hydronephrosis and function after the infection settled and operation was deferred. The child is on close follow up and is at present infection free.

Multiple ureteric strictures with PUJO and VUJO

Figure 6.2: intraoperative pictures of multiple strictures with obstruction at PUJ and VUJ



POSTOPERATIVE EVALUATION

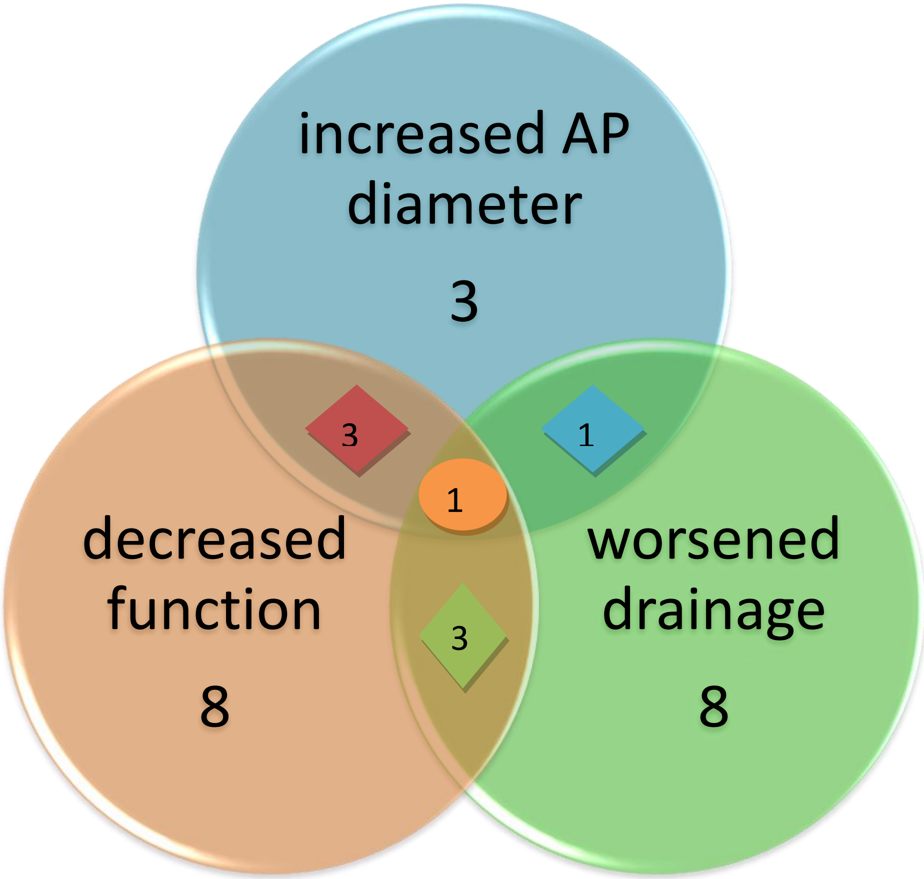
88 children had both pre and postoperative ultrasound and renal scan available. The combined results are summarised below.

Figure 6.3: summary of results of DRS and US(n=88)

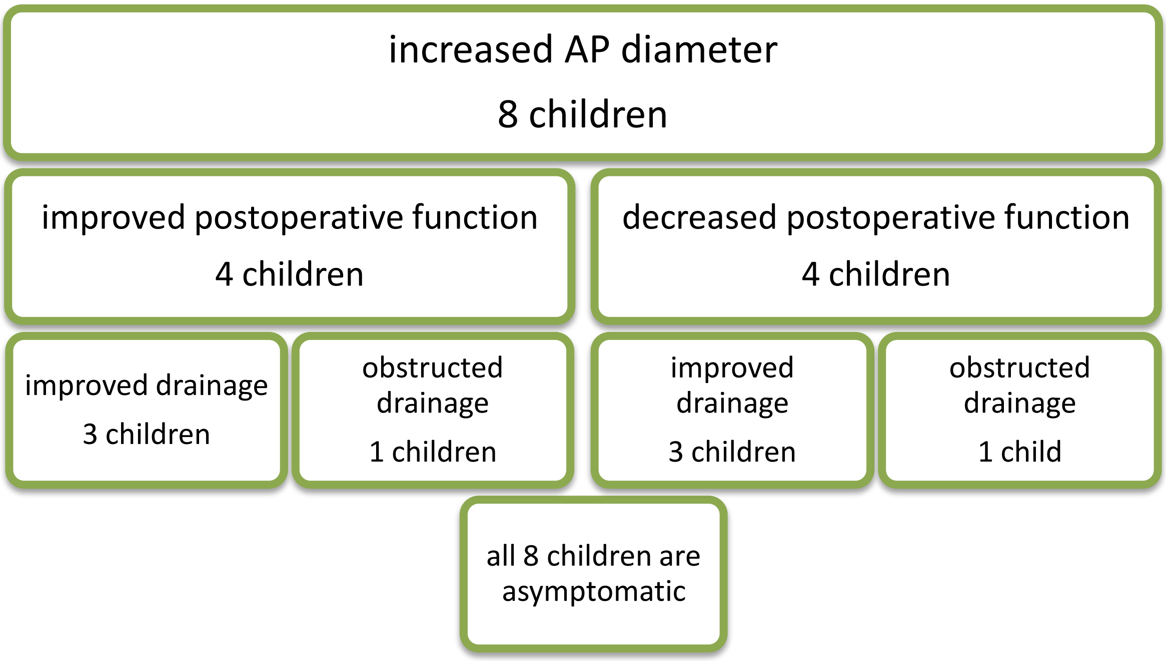
	Split renal function	**Drainage**	**AP diameter**
Improvement	50	75	77
Deterioration	15	13	8
No change	10	0	3
Not accountable	13 sn SRF	2 NFK	

Over all there seems to be a good correlation between the ultrasound findings and the drainage pattern. However on closer examination of the 11 children who had an obstructive drainage pattern only 1 had no change in the AP diameter whereas 10 showed improvement in the AP diameter. All 8 children with an increasing AP diameter showed improvement in drainage except 1 child with a poorly functioning kidney. Comparing the split renal function to ultrasound we found that of the 8 children with increasing AP diameter on ultrasound, 6 had improvement in the split function, 1 showed no change and 1 was a supranormal functioning kidney. Thus there does not seem to be a correlation between the renal scintigraphy findings and AP diameter. Almodhen et al examined the use of ultrasound in the postoperative follow up and found a good correlation between the drainage pattern on renal scintagraphy and the SFU grade on ultrasound(34). A similar association was found by Cost et al in their study(2).

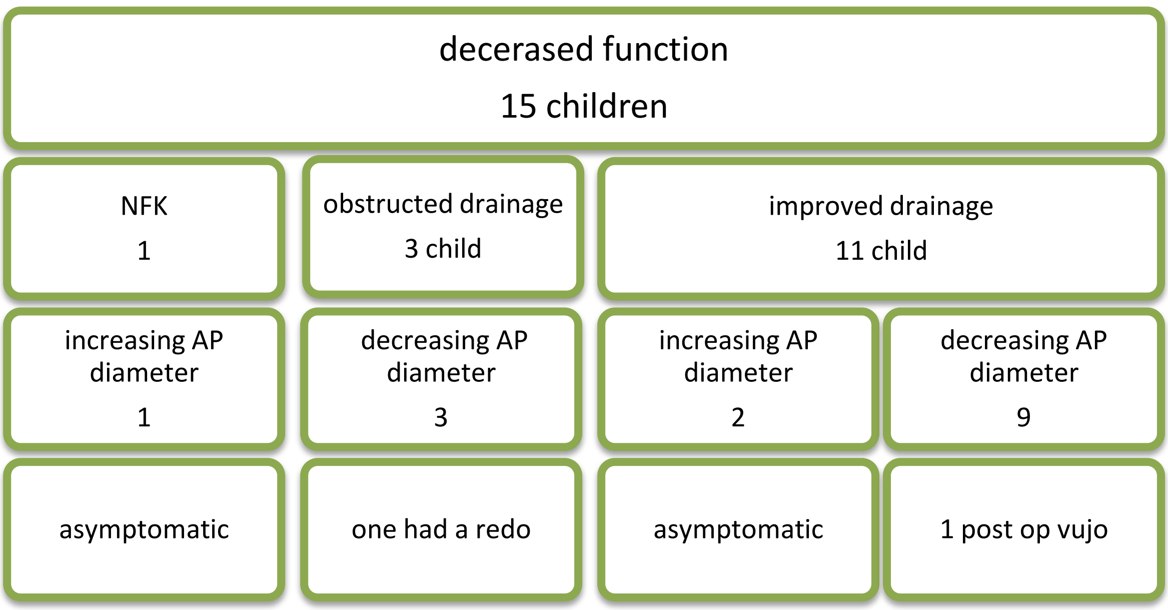
Figure 6.3: a venn diagram showing the overall results of ulatasound and renal scintigraphy in children who did not have optimal results i.e. increasing AP diameter, deterioration in function or obstructed drainage.



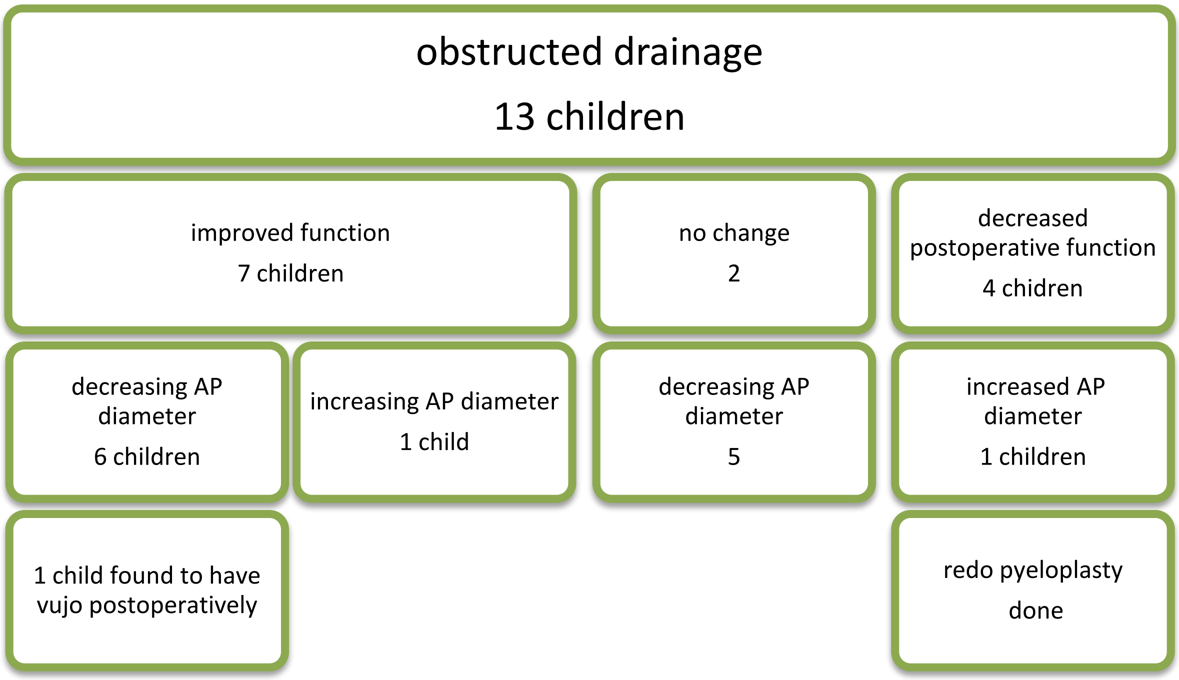
Subset 1: outcome of children with increased AP diameter post pyeloplasty



Subset 2: outcome of children with decreased function post pyeloplasty



Subset 3: outcome of children with obstructed drainage post pyeloplasty



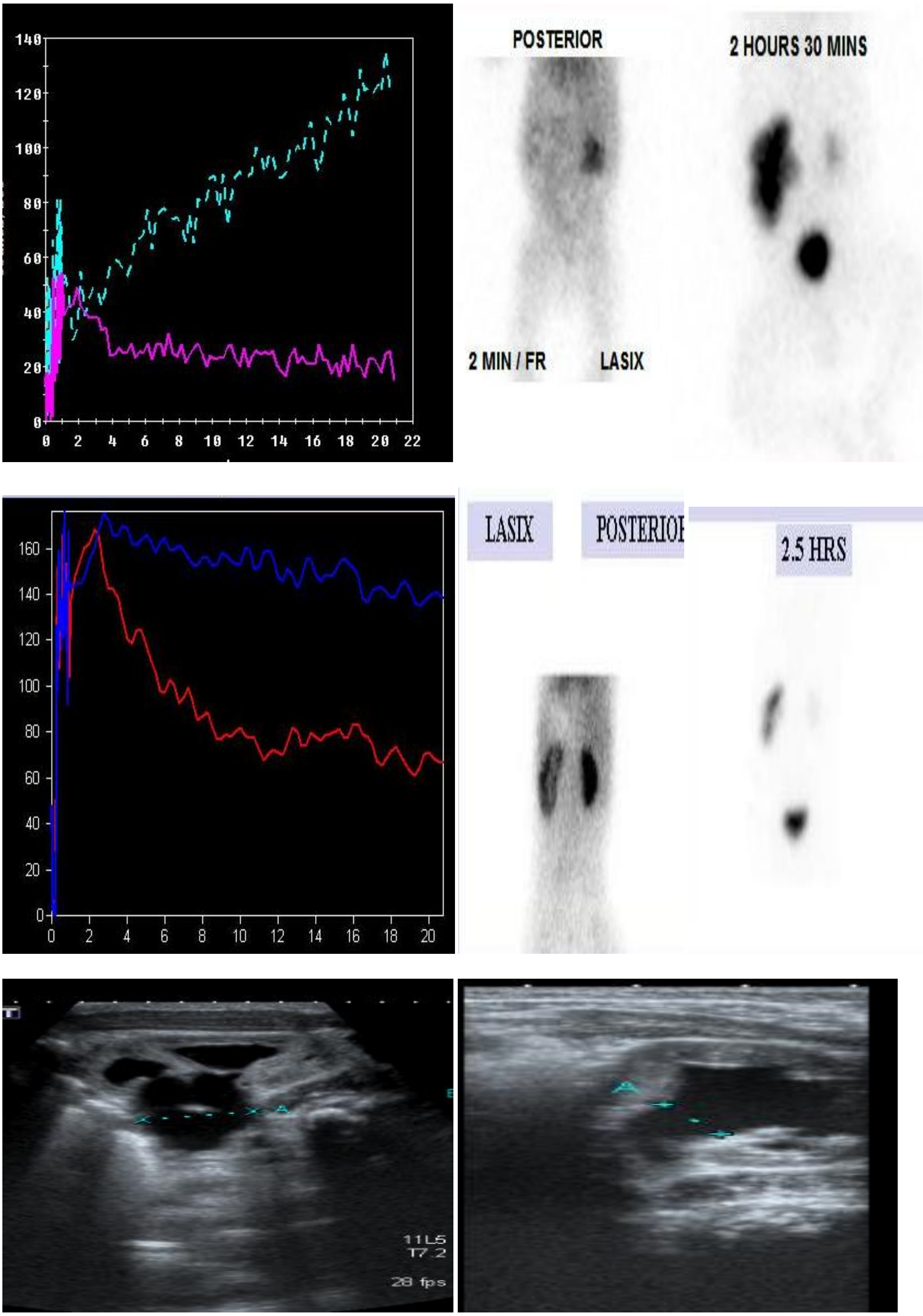
Statistical analysis of all three variables.

There is no statistical correlation between the US and DRS variables

	Test of Symmetry			Test of H0: Kappa = 0			
	Statistic (S)	DF	Pr > S	ASE under H0	Z	One-sided Pr > Z	Two-sided Pr > |Z|
SRF by US	19.9236	3	0.0002	0.0650	1.3770	0.0843	0.1685
Drainage by US	5.3333	3	0.1490	0.0740	0.0816	0.2339	0.0859

	Weighted Kappa Coefficient				Test of H0: Weighted Kappa = 0			
	Weighted Kappa	ASE	95% Lower Conf Limit	95% Upper Conf Limit	ASE under H0	Z	One-sided Pr > Z	Two-sided Pr > |Z|
SRF by US	**0.0769**	**0.0772**	**0.0743**	**0.2282**	**0.0671**	**1.1466**	**0.1258**	**0.2516**
Drainage by US	**0.0972**	**0.7614**	**0.2232**	**0.4464**	**0.0978**	**0.9207**	**0.1786**	**0.3572**

Figure 6.4: Renogram and US of a child showing partial obstructed drainage, improved function and reduction in AP diameter postoperatively.



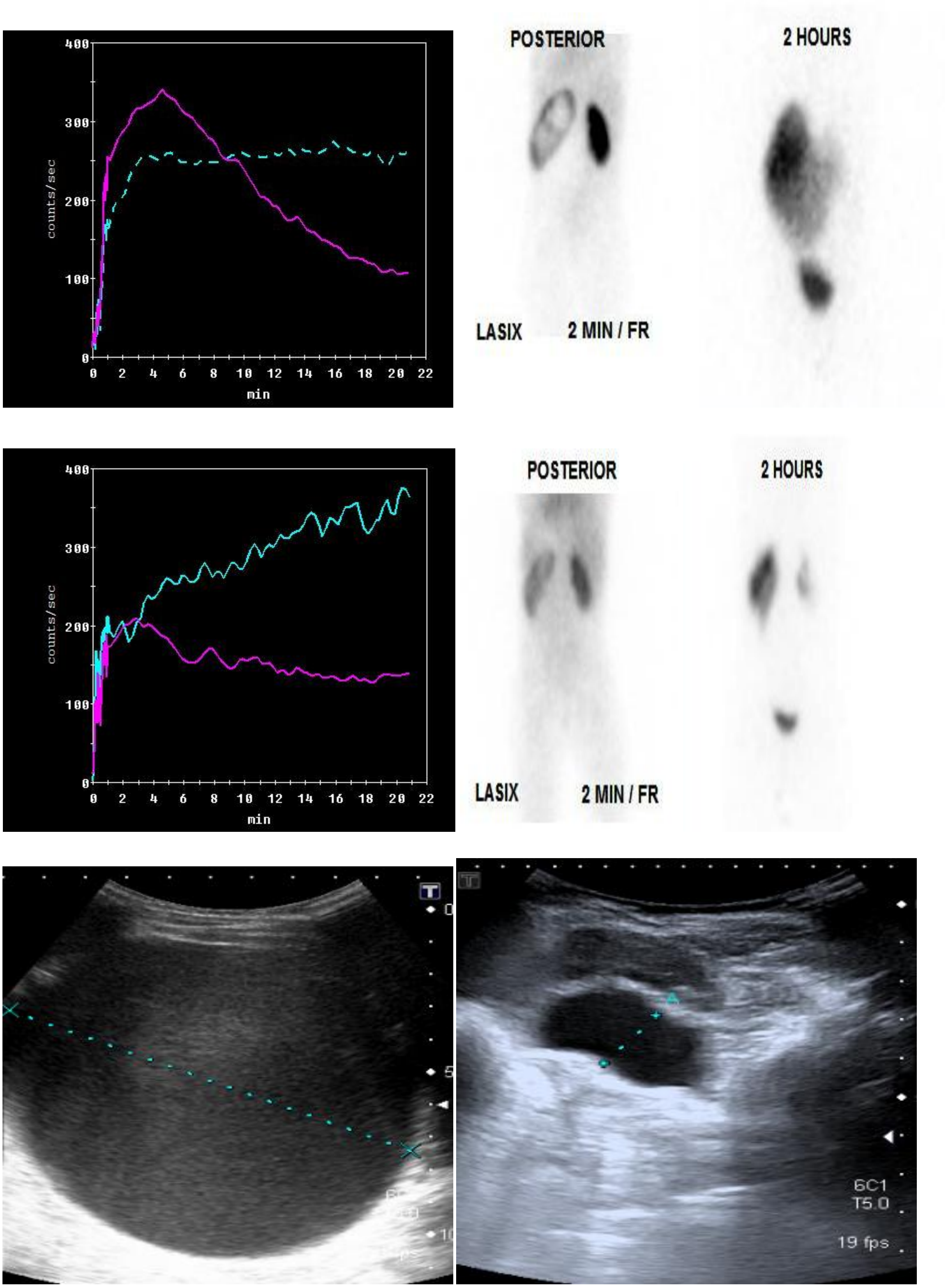


Figure 6.5: Renogram of a child showing slow patent drainage postoperatively. The US for the same child showing a reduction of AP diameter from 10 cm to 3.6cm.

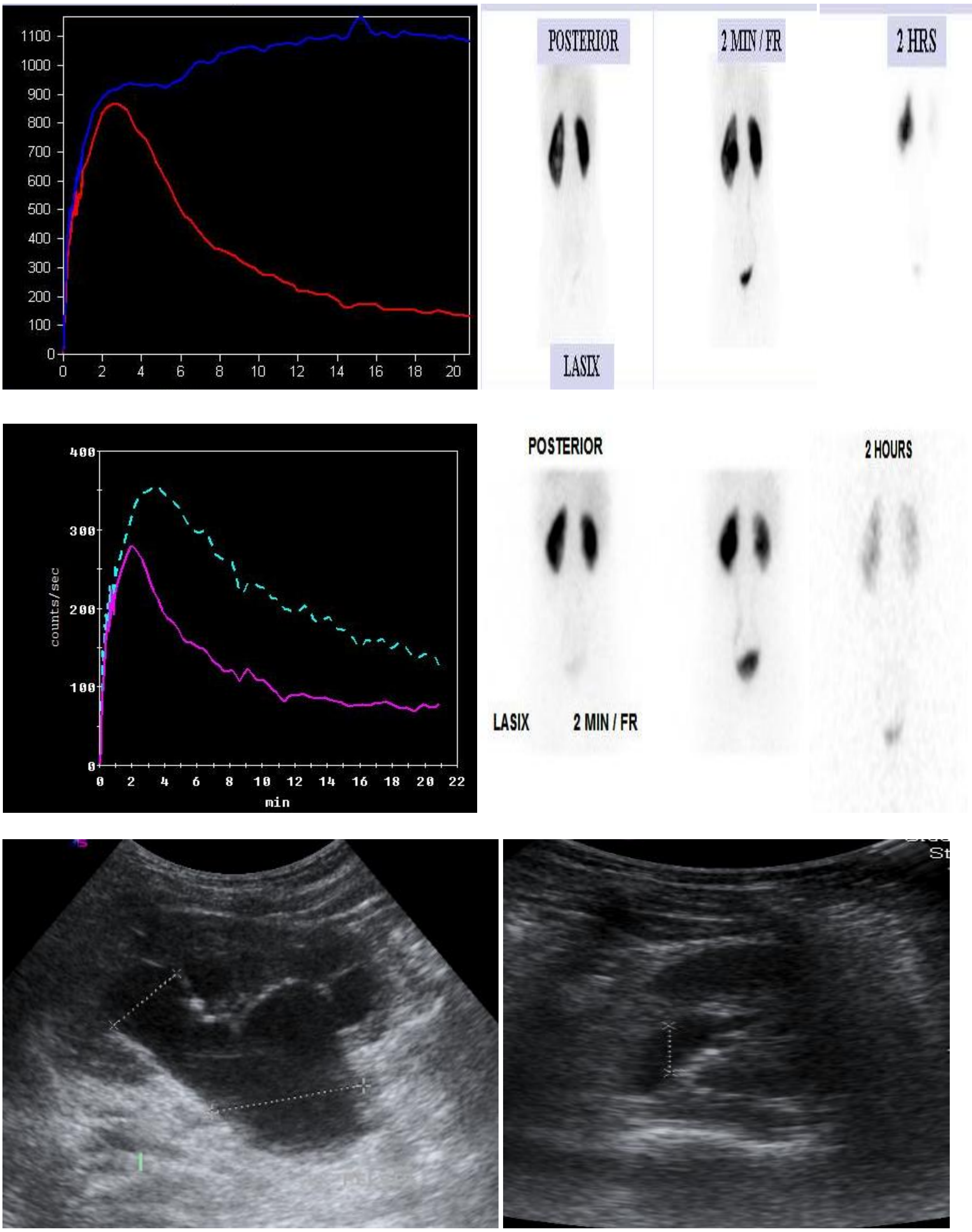


Figure 6.6: Renogram of a child showing patent postoperative drainage and improved function. US showing reduction in the AP diameter.

SUMMARY AND CONCLUSIONS

SALIENT FINDINGS

1. The number of operations being performed is increasing every year.

2. 80% are of operated children are boys and 65% affected moieties are on the left

3. The average age at operation is approximately 4 years. Less infants are being operated in recent years.

4. The most common presenting complaint is pain followed by UTI and mass.

5. The hospital stay is getting shorter especially with the use of internal stents.

6. 96% percent of children had symptomatic relief after pyeloplasty.

7. The commonest immediate postoperative complication is UTI.

8. Pyeloplasty failure can occur any number of years after the initial operation.

9. The results after redo pyeloplasty are good.

10. The appendix may be used to replace a very unhealthy ureter but it is to be kept as a last resort.

11. Split renal function improves marginally after pyeloplasty and cannot be a measure of successful pyeloplasty.

12. Antenatally detected kidneys a slightly better preserved than symptomatic ones.

13. Use of internal stent offered the best improvement in split function over the initial value.

14. 84% children showed improvement in drainage after pyeloplasty.

15. There is a significant reduction in the AP diameter of the renal pelvis post pyeloplasty.

FURTHER STUDIES REQUIRED

The use of ultrasound in the follow up of children post pyeloplasty is an avenue worth exploring. It will decrease the exposure to ionizing radiation, cost and discomfort to the child thus increasing the compliance and follow up.

In our institution at present the sonologist measures the AP diameter for children with PUJO. We do not have data of the SFU grading of the kidney. The AP diameter alone may not be sufficient to provide a an alternative to renal scintigraphy in follow up.

We plan to design a study to measure the degree of hydronephrosis (SFU grading) and compare it to the diuretic renal scan and hope to find a correlation that will help to establish US as the primary screening follow up study. This will also help us to draw up guidelines defining the instances in which scintigraphy will be required.

Secondly we would like to generate long term follow up of all the children who had supranormal functioning kidneys so that we can verify the hypothesis that supranormal function is a bad prognostic factor.

REFERENCES

1. Smith KE, Holmes N, Lieb JI, Mandell J, Baskin LS, Kogan BA, et al. Stented versus nonstented pediatric pyeloplasty: a modern series and review of the literature. J Urol. 2002 Sep;168(3):1127-30.
2. Cost NG, Prieto JC, Wilcox DT. Screening ultrasound in follow-up after pediatric pyeloplasty. Urology. 2010 Jul;76(1):175-9.
3. Nelson CP, Park JM, Dunn RL, Wei JT. Contemporary trends in surgical correction of pediatric ureteropelvic junction obstruction: data from the nationwide inpatient sample. J Urol. 2005 Jan;173(1):232-6.
4. Bouzada MC, Oliveira EA, Pereira AK, Leite HV, Rodrigues AM, Fagundes LA, et al. Diagnostic accuracy of fetal renal pelvis anteroposterior diameter as a predictor of uropathy: a prospective study. Ultrasound Obstet Gynecol. 2004 Dec;24(7):745-9.
5. Lee RS, Cendron M, Kinnamon DD, Nguyen HT. Antenatal hydronephrosis as a predictor of postnatal outcome: a meta-analysis. Pediatrics. 2006 Aug;118(2):586-93.
6. Yang Y, Hou Y, Niu ZB, Wang CL. Long-term follow-up and management of prenatally detected, isolated hydronephrosis. J Pediatr Surg. 2010 Aug;45(8):1701-6.
7. Ismaili K, Hall M, Donner C, Thomas D, Vermeylen D, Avni FE. Results of systematic screening for minor degrees of fetal renal pelvis dilatation in an unselected population. Am J Obstet Gynecol. 2003 Jan;188(1):242-6.
8. Kass EJ, Fink-Bennett D. Contemporary techniques for the radioisotopic evaluation of the dilated urinary tract. Urol Clin North Am. 1990 May;17(2):273-89.
9. Buyukdereli G, Guney IB. Role of technetium-99m N,N-ethylenedicysteine renal scintigraphy in the evaluation of differential renal function and cortical defects. Clin Nucl Med. 2006 Mar;31(3):134-8.
10. Lima MC, de Lima ML, Pepe CF, Etchebehere EC, Santos AO, Amorim BJ, et al. Technetium-99m-L,L-ethylenedicysteine is more effective than technetium-99m diethylenetriamine penta-acetic acid for excluding obstruction in patients with pyelocalicinal dilation. Urology. 2010 Aug;76(2):283-8.
11. Prigent A, Cosgriff P, Gates GF, Granerus G, Fine EJ, Itoh K, et al. Consensus report on quality control of quantitative measurements of renal function obtained from the renogram: International Consensus Committee from the Scientific Committee of Radionuclides in Nephrourology. Semin Nucl Med. 1999 Apr;29(2):146-59.
12. Davies RJ, Jones DJ, Croft DN, Shuttleworth KE. An assessment of Anderson-Hynes pyeloplasty by radioisotope renography. Proc R Soc Med. 1969 Nov;62(11 Part 1):1123-4.
13. Wang TM, Chang PL, Kao PF, Hsieh ML, Huang ST, Tsui KH. The role of diuretic renography in the evaluation of obstructed hydronephrosis after pediatric pyeloplasty. Chang Gung Med J. 2004 May;27(5):344-50.
14. Nam JK, Lee SD, Chung MK. Modified differential renal function measurement revised by renal cross sectional area in children with ureteropelvic junction obstruction. Korean J Urol. 2010 Apr;51(4):271-5.
15. Conway JJ. "Well-tempered" diuresis renography: its historical development, physiological and technical pitfalls, and standardized technique protocol. Semin Nucl Med. 1992 Apr;22(2):74-84.
16. Ham WS, Jeong HJ, Han SW, Kim JH, Kim DK. Increased nephron volume is not a cause of supranormal renographic differential renal function in patients with ureteropelvic junction obstruction. J Urol. 2004 Sep;172(3):1108-10.
17. Oh SJ, Moon DH, Kang W, Park YS, Park T, Kim KS. Supranormal differential renal function is real but may be pathological: assessment by 99m technetium mercaptoacetyltriglycine renal scan of congenital unilateral hydronephrosis. J Urol. 2001 Jun;165(6 Pt 2):2300-4.
18. Capolicchio G, Jednak R, Dinh L, Salle JL, Brzezinski A, Houle AM. Supranormal renographic differential renal function in congenital hydronephrosis: fact, not artifact. J Urol. 1999 Apr;161(4):1290-4.

19. Kim YS, Do SH, Hong CH, Kim MJ, Choi SK, Han SW. Does every patient with ureteropelvic junction obstruction need voiding cystourethrography? J Urol. 2001 Jun;165(6 Pt 2):2305-7.
20. Darge K, Anupindi SA, Jaramillo D. MR imaging of the abdomen and pelvis in infants, children, and adolescents. Radiology. 2011 Oct;261(1):12-29.
21. McAleer IM, Kaplan GW. Renal function before and after pyeloplasty: does it improve? J Urol. 1999 Sep;162(3 Pt 2):1041-4.
22. Thomas DF. Prenatally diagnosed urinary tract abnormalities: long-term outcome. Semin Fetal Neonatal Med. 2008 Jun;13(3):189-95.
23. Culp OS, De WJ. A pelvic flap operation for certain types of ureteropelvic obstruction; preliminary report. Proc Staff Meet Mayo Clin. 1951 Dec 5;26(25):483-8.
24. Scardino PL, Prince CL. Vertical flap ureteropelvioplasty. South Med J. 1953 Apr;46(4):325-31.
25. Castagnetti M, Berrettini A, Cimador M, Sergio M, Rigamonti W, DeGrazia E. Complications of trans-anastomotic externalised stents in open pyeloplasty: influence of the method of placement, the duration of stenting, and the associated bladder drainage. Pediatr Surg Int. 2010 Mar;26(3):309-13.
26. Chandrasekharam VV. Is retrograde stenting more reliable than antegrade stenting for pyeloplasty in infants and children? Urology. 2005 Dec;66(6):1301-4; discussion 4.
27. Braga LH, Lorenzo AJ, Bagli DJ, Keays M, Farhat WA, Khoury AE, et al. Risk factors for recurrent ureteropelvic junction obstruction after open pyeloplasty in a large pediatric cohort. J Urol. 2008 Oct;180(4 Suppl):1684-7; discussion 7-8.
28. Giddens JL, Grasso M. Retrograde ureteroscopic endopyelotomy using the holmium:YAG laser. J Urol. 2000 Nov;164(5):1509-12.
29. Faerber GJ, Richardson TD, Farah N, Ohl DA. Retrograde treatment of ureteropelvic junction obstruction using the ureteral cutting balloon catheter. J Urol. 1997 Feb;157(2):454-8.
30. Bansal P, Gupta A, Mongha R, Narayan S, Das RK, Bera M, et al. Laparoscopic versus open pyeloplasty: comparison of two surgical approaches- a single centre experience of three years. Indian J Surg. 2011 Aug;73(4):264-7.
31. Braga LH, Lorenzo AJ, Bagli DJ, Mahdi M, Salle JL, Khoury AE, et al. Comparison of flank, dorsal lumbotomy and laparoscopic approaches for dismembered pyeloplasty in children older than 3 years with ureteropelvic junction obstruction. J Urol. 2010 Jan;183(1):306-11.
32. Piaggio LA, Franc-Guimond J, Noh PH, Wehry M, Figueroa TE, Barthold J, et al. Transperitoneal laparoscopic pyeloplasty for primary repair of ureteropelvic junction obstruction in infants and children: comparison with open surgery. J Urol. 2007 Oct;178(4 Pt 2):1579-83.
33. Seixas-Mikelus SA, Jenkins LC, Williot P, Greenfield SP. Pediatric pyeloplasty: comparison of literature meta-analysis of laparoscopic and open techniques with open surgery at a single institution. J Urol. 2009 Nov;182(5):2428-32.
34. Almodhen F, Jednak R, Capolicchio JP, Eassa W, Brzezinski A, El-Sherbiny M. Is routine renography required after pyeloplasty? J Urol. 2010 Sep;184(3):1128-33.
35. Chipde SS, Lal H, Gambhir S, Kumar J, Srivastava A, Kapoor R, et al. Factors predicting improvement of renal function after pyeloplasty in pediatric patients: a prospective study. J Urol. 2012 Jul;188(1):262-5.
36. Pohl HG, Rushton HG, Park JS, Belman AB, Majd M. Early diuresis renogram findings predict success following pyeloplasty. J Urol. 2001 Jun;165(6 Pt 2):2311-5.
37. Lim DJ, Walker RD, 3rd. Management of the failed pyeloplasty. J Urol. 1996 Aug;156(2 Pt 2):738-40.
38. Karnak I, Woo LL, Shah SN, Sirajuddin A, Kay R, Ross JH. Prenatally detected ureteropelvic junction obstruction: clinical features and associated urologic abnormalities. Pediatr Surg Int. 2008 Apr;24(4):395-402.
39. Bomalaski MD, Hirschl RB, Bloom DA. Vesicoureteral reflux and ureteropelvic junction obstruction: association, treatment options and outcome. J Urol. 1997 Mar;157(3):969-74.

40. Hollowell JG, Altman HG, Snyder HM, 3rd, Duckett JW. Coexisting ureteropelvic junction obstruction and vesicoureteral reflux: diagnostic and therapeutic implications. J Urol. 1989 Aug;142(2 Pt 2):490-3; discussion 501.
41. Alizadeh F, Izadpanahi MH, Khorrami MH, Nouri-Mahdavi K. Ureteropelvic junction obstruction presenting after antireflux surgery. Adv Biomed Res. 2012;1:20.
42. Moodley P, Demaria J, Lorenzo AJ, Pippi Salle JL, Braga LH. Concurrent ureteropelvic and ureterovesical junction obstruction in children: the value of retrograde pyelography. J Pediatr Urol. 2010 Apr;6(2):117-21.

YEAR	Hnum	Age	Sex	disease side	pre operative	post operative	improve	presentation	dos	stents	spl assoc	us,pre,date	us,pre, size	us,ap,pr	us,post,date	us,post,size	us,post,ap	us improve
2011	153164C	8	1	2	27	18	1	1	17.2.11	2	HORSESHOE	7.12.10	7.6/10.9	5.9	6.8.11		1.3	
2011	707692D	1	2	2	53	52	1	10	18.4.11	2	DUPLEX LM	22.2.1	6.2/9.6	2.4	14.2.12	6.9/9.4	1.5	1
2011	974846D	2	2	2	30	36	1	2	15.7.11	2		28.6.11	6.7/7.4			6.4/5.6	0.9	
2011	974783D	4	2	2	45	51	1	10	17.8.11	1		29.7.11	6.9/7.9	1.9	21.2.12	7.7/7.7	1	
2011	977965D	8	1	2	52	52	1	1	26.7.11	2		20.7.11	7.8/13.5	GHN	10.2.12	7.9/10.8	1.1	1
2011	073749C	10	2	2	25	25	1	9	1.3.11	1		25.1.11	7.6/9	4.2	18.11.11	7.6/7.5	1.1	
2011	883033D	4	2	2	35	41	1	1	4.3.11	1		26.2.11	10.7/11.6	22	17.10.11	7.4/7.8	17	
2011	992296D	4DAYS	1	2	57	50	1	10	31.7.11	2		21.6.11	3.5/4.8	2.1	13.2.12	5/5.8	1.3	
2011	923551D	4	1	2	43	49	1	3	26.4.11	2		13.5.11	10/10.2	10	17.11.11	7.9/9.2	3.6	
2011	997568D	6	2	2	45	48	1	1	12.8.11	1		30.7.11	7.4/9.8	3.7	17.2.12	7.5/10.5	1.7	
2011	528132D	3	2	2	43	52	1	9	4.8.11	1		20.7.11	7.2/11.9	5				
2011	025992F	10	1	2	30	26	1	3	27.9.11	2		15.9.11	8.8/23	GHN				
2011	916138D	3	2	2	42	49	1	9	17.11.11	1		4.11.11	8/8.7	4	16.5.12	8.3/8.5	1.9	1
2011	060706F	4	1	2	59	58	1	1	11.11.11	1	LAP	9.11.11	7.2/8.4	2.2				
2011	055472F	3	2	2	56	54	1	1	26.10.11	1	LAP,REDO	17.10.11	7.1/10.3	2.9				
2011	761740D	4	2	2	52	53	1	9	10.2.11	1		3.2.11	6.8/8.4	3	30.6.11	5.8/8.4	2.4	
2011	929836D	0.3	2	2	47	48	1	9	5.5.11	2		25.4.11	6/7.3	3.7	13.12.11	6.8/6.4	1.8	
2011	956953D	1	2	2	20	52	1	10	22.6.11	2		8.6.11	8.5/12.2	2.5	8.2.12	5.9/7	2.1	
2011	882762D	1	2	2	35	37	1	10	3.6.11	1		27.4.11	5.2/5.6	3.5	18.1.12	6.5/6.8	1	1
2011	968536D	0.6	2	2	19	26	1	3	7.12.11	1		8.9.11	5.3/6.2	4				
2011	177067F	8	2	2	55	51	1	1	5.12.11	1	LAP	23.11.11	8.2/11.4	5				
2011	735472D	1	2	2	40	42	1	1	8.3.11	1		15.1.11	7.5/10	5.6	10.9.11	8/7.1	2.5	
2011	084829F	6	2	2	51	51	1	2	16.12.11	1		3.12.11	7.7/9	3.1				
2011	852194D	1	2	2	28	19	1	3	11.11.11	2		5.1.11	5.6/12.4	4	2.2.12	6.9/8.9	3	
2011	093530F	2	1	2	47	47	1	4	26.12.11	1	LAP	14.12.11	6.8/					
2010	606626D	6	1	2	49	53	1	1	6.1.10	2								
2010	646541D	6	2	2	2	12	1	3	22.4.10	2	NIL	27.2.10	8.9/GHN					
2010	742231D	2	2	2	43	43	1	4	6.8.10	2								
2010	611233D	4	2	2	54	55	1	1	8.1.10	2	FROM DS							
2010	698612D	10	2	2	21	14		1	21.5.10	2	NIL	20.5.10	11.1/10.3	2.3/4.8	21.4.11	10.8/10.5	2.5/4.0	1
2010	763792D	0	2	2	28	49	1	4	24.8.10	2	LEFT HEMI HYPERTROPHY	18.8.10	6.5/13.4	11.2	27.3.12	7.3/10	3.3	1
2010	667431D	5	2	2	15	27		3	23.4.10	2	MCU NOR	31.3.10	9.1/GHN	GROSS				
2010	383553D	7	2	2	26	29	1	1	15.6.10	2		6.1.09	8.6/9.8	1.8	3.6.10	9.1/9.1	2.4	
2010	114502D	3	2	2	49	69	1	1	23.11..10	1	REDO. DONE IN OCT 2007							
2010	368525D	3	2	2	54	52	1	2	3.12.10	2								
2010	073825C	8	2	2	44	50	1	2		2								
2010	603630D	0	2	2	54	51	1	10	26.3.10	2								
2010	712300D	10	2	2	40	49	1	2	16.7.10	2		13.6.10	8.2/12.3	4.8	14.6.11	7.6/11	2.2	1
2010	752307D	5	2	2	42	47	1	1		2								
2010	689005D	0	2	2	56	58	1	10	11.5.10	2	NIL				1.9.11	6.3/8.6	1.9	
2010	610660D	14	2	2	42	40	1	1	6.5.10	2	NIL	5.1.10	10.3/10.4	2.8	28.12.10	10.8/9.6	1.3	1
2010	682673D	0	2	2	46	56	1	10		2								
2010	577280D	5	2	2	27	32	1	2	19.1.10	2		18.11.09	6.4/7.6	2.8	24.7.10	6.8/6.3	0.6	1
2009	481348D	0	2	2	53	45		2	26.6.09	2		17.6..09	5/9.6	4.8	10.6.10	6.3/6.2	1.5	1
2009	604961D	6	2	2	51	57	1	9	30.12.09	2	VESSEL	24.12.09	8/9.9	4.2	7.6.10	8.2/9.1	1.3	1
2009	186365D	1	2	2	16	21	1	10	5.5.09	2		15.1.09	7.3/9.7	4.4				
2009	487606D	1	2	2	51	54	1	5	2.7.09	2		29.6.09	6.8/7.7	mhn				
2009	484829D	8	2	2	29	30	1	9	26.6.09	2								
2009	585239B	13	2	2	43	34	1	1	2.10.09	2								
2009	413026D	1	2	2	46	33		10	3.3.09	2								
2009	583874D	3	1	2	47	47	0	1	26.11.09	2								
2009	574759D	11	2	2	45	52	1	1	12.11.09	2								
2009	484232D	5	2	2	55	49	1	2		2								
2009	449326D	1	2	2	9	17	1	3	30.4.09	2								
2009	376299D	0	2	2	54	53		10	27.2.09	2								
2009	473626D	5	2	2	7	15	1	1	16.6.09	2								
2009	438819D	1	2	2	39	51	1	2	21.4.09	2								
2009	507681D	0	1	2	47	51	1	9		2								
2009	204122D	0	1	2	41	43	1	10	30.10.09	2								
2009	561652D	6	2	2	20	1	2	2	2.11.09	2								
2009	375377D	0	2	2	49	49	1	10	11.2.09	2	DUPLEX							
2009	539485D	0	2	2	45	52	1	10		2	LEFT UDT							
2009	611499C	5	1	2	41	57		10	6.3.09	2								
2009	499683D	3	2	2	11	20	1	3		2								
2009	990893C	2	2	2	26	22		2	28.10.09	2	L VUR							
2009	588511D	10	2	2	51	42	1	1	3.12.09	2								

2009	486469D	9	2	2	40	43	1	1		2										
2009	500789D	5	2	2	29	32	1	1		2										
2009	507180D	8	2	2	44			1		2										
2009	388875D	0	2	2	48	49	1	10	16.6.09	2										
2009	434767D	0	1	2	56	56	1	3	7.4.09	2		31.3.09	6.5/8.4		2.3	31.3.11	7.9/8.8	N		1
2009	467628D	6	2	2	23	37	1	3	3.6.09	2										
2009	921803C	2	2	2	46	46	1	10		2										
2008	194074D	0	2	2	49	46	1	10	9.6.08	2	LEFT INGUINAL HERNIA									
2008	218557D	4	1	2	20	25	1	1	21.4.08	2	CROSSING VESSEL, BIFID URETER									
2008	885435C	3	1	2	3	3	0	1	8.7.08	2		3.7.08	7.8/10		4.9	20.7.11	9.7/6.3		1.6	2
2008	203345D	0	2	2	37	53	1	10	27.3.08	2										
2008	085650D	0	1	2	52	47	0	2	5.3.08	2										
2008	302447D	2	2	2	19	7	1	3	9.9.08	2		28.8.08	6.5/11.6	GHN		25.7.09	6.9/8	MHN		1
2008	204930D	10	2	2	55	58	1	1	16.4.08	2										
2008	275406D	0	2	2	38	56	1	2	30.12.08	2										
2008	276795D	3	2	2	40	50	1	7	29.7.08	2		19.7.08	6.4/10.5		3.5	21.4.10	7.1/9.5		1.5	1
2008	220123D	3	2	2	6	14	1	10	22.4.08	2										
2008	193301D	3	2	2	30	37	1	1	25.3.08	1										
2008	348484D	5	2	2	25	23	0	6	13.11.08	2		14.11.08	8.3/10.3	0.88/4.12						
2008	363688D	1	2	2	50	61	1	2	17.12.08	2										
2008	826096C	5	2	2	64	59	1	2	5.3.08	2										
2008	316159D	6	2	2	49	52	1	1	3.10.08	2		16.9.08	7.5/9		2.5	13.10.09	8.6/8.2		0.8	1
2008	891321C	2	2	2	49	37	1	6	14.8.08	2	POSTMED ROTATED PELVIS	5.8.08	6.8/11.3	GHN						
2008	155815D	8	2	2	53	51	1	2	2.1.08	2										
2008	185022D	4	2	2	14	18	1	6	25.3.08	2										
2008	291505D	3	1	2	9	13	1	3	26.8.08	2		13.8.08	7.6/14.9	GHN		18.2.09	9.3/7.7		5.2	1
2008	191370D	0	2	2	47	52	1	2	6.3.08	2										
2007	934225C	1	2	2	52	50	1	9	27.3.07	2										
2007	052159D	0	2	2	41	49	1	10	30.9.07	2										
2007	051442D	2	2	2	9	9	0	4	6.7.07	1	NEPH IN DEC 07									
2007	995559C	1	2	2	29	49	1	10	5.4.07	2										
2007	116536D	5	1	2	16	62	1	3	29.10.07	2										
2007	094776D	7	2	2	19	15	1	1	25.9.07	2										
2007	073327D	0	2	2	42	39		10	25.10.07	2	LEFT VUJ OBST IN 2008 REIMPLANTED									
2007	681510C	1	2	2	31	30		10	11.1.07	2										
2007	987599C	2	2	2	60	57	1	2	15.3.07	2										
2007	816706C	4	2	2	46	51	1	2	19.9.07	2	CROSSING VESSEL,									
2006	908198C	8	2	2	48	48	1	10	23.10.06	1										
2006	890950C	10	2	2	30	38	2	9	20.9.06	2										
2006	798522C	12	2	2	40	43	1	5	9.5.06	2										
2006	747716C	4	2	2	22	23	1	1	16.3.06	2										
2006	717542C	6	2	2	58	60	1	10	22.5.06	2										
2006	822411C	5	1	2	14	24	1	1	24.5.06	2										
2006	883620C	0	2	2	16	35	1	4	6.9.06	2										
2006	887324C	0	2	2	40	49	1	10	12.12.06	2										
2006	843987C	2	2	2	48	50	1	6	5.7.06	2										
2011	991699D	1	2	1	47	46	0	10	12.8.11	1		25.7.11	7.3/6.8		2.4	24.4.12	7.8/7.2		0.8	
2011	993010D	0.4	2	1	14	20	1	3	9.8.11	1		27.7.11	13.6/8.5		9	21.3.12	9/7.7			
2011	943800D	4	2	1	29	27	1	1	10.5.11	2		4.5.11	10.2/6.7		3.7	15.11.11	6.6/7		1	
2011	062445F	7	2	1	28	36	1	1	15.11.11	2		28.10.11	16/8.9		4.5					
2011	861261D	4	2	1	41	43	1	6	19.1.11	1		10.1.11	6.6/7.4		13.1	9.8.11	8.6/7.1		5.8	1
2011	011588F	9	1	1	16	14	0	1	12.10.11	1	REDO	23.8.11	8.7/7.6		2.4					
2011	950646C	5	1	1	49	46		1	23.9.11	1		30.8.11	6.9/7.4		2.2					
2011	894666D	11	2	1	50	50	1	1	9.3.11	2		4.3.11	11.8/8.7		3.4					
2011	977887D	7	2	1	25	17	1	1	4.9.11	1	LAP TRANS	7.7.11	9.6/9		2.7	11.9.12	9.5/9.4		1.7	
2010	693654D	0	1	1	45	49	1	10		2										
2010	827887D	1	1	1	32	32	1	2	23.11.10	2										
2010	841475D	13	2	1	32	31	1	1	10.12.10	1										
2010	776942D	1	2	1	48	54	1	2	8.10.10	2		1..10.10	GHN R			12.3.11	7.3/8.4		2.2	
2010	423318D	1	1	1	53	52	1	1	28.1.10	2										
2010	803280D	14	2	1	16	16	1	1	25.11.10	2										
2010	574353D	2	1	1	17	41	1	4		2										
2010	671447D	4	2	1	42	51	1	1	15.4.10	2	MCU NOR	8.4.10	12/8.0	GROSS		20.5.11	9.0/8.0		0.7	1
2010	663601D	8	2	1	6	32	1	1		1	NO	23.3.10	16.7/8.9		9.8	28.9.11	13.8/9.4			1
2010	361187D	9	2	1	30	36	1	1	18.6.10	2		30.5.10	17.6/9.6		6.4	28.12.10	11.2/9.2		3.5	1
2010	814145D	6	1	1	32	40	1	1	9.11.10	2										
2010	664012D	1	1	1	28	24	1	2	8.4.10	2	NIL	29.3.10	6.6/6.6		3					

2010	664655D	1	2	1	16	19	1	2	7.4.10	2	BL VUR	27.3.10	8.8/6.6		4	13.7.10	7.2/6.6		1.5	1			
2010	718816D	1	2	1	30	33	1	2	2.7.10	2	HIGH INSERTION	17.6.10	8.2/6.3		7.4	4.2.11	7.8/6.3	N		1			
2010	765590D	0	2	1	29	36	1	3	10.12.10	1													
2009	589415D	3	1	1	19	21	1	3	3.12.09	2													
2009	571614D	7	2	1	16	44	1	1	18.11.09	2													
2009	528067D	9	2	1	37	49	1	1		2													
2009	601931D	6	2	1	25	53	1	3	23.12.09	1													
2009	127265D	1	2	1	43	42		10		2													
2009	730969C	4	2	1	46	47	1	10		2													
2009	575217D	4	2	1	36	44	1	1	5.12.09	2													
2009	581005D	12	2	1	48	51	1	9	24.11.09	2													
2009	485619D	3	2	1	34	30		2		2													
2009	399724D	0	2	1	48	48		2	11.3.09	2													
2009	397041D	4	1	1	53	49	1	1	16.2.09	2													
2009	934214C	5	2	1	22	30	1	2	30.3.09	2	BL VUJ OBST, L TO R TUU DONE IN 2006												
2008	266570D	0	2	1	17	21	1	2	4.7.08	2	HERNIA	1.7.08	11.9/7.5	11/2.3									
2008	221068D	3	2	1	28	26	1	1	21.5.08	2													
2008	280958D	0	1	1	43	45	1	10	28.10.08	2		28.7.08	7.5/4.8		1	16.9.09	6.9/5		1.1	1			
2008	235724D	0	1	1	39	25	1	1	30.5.08	2													
2008	263650D	0	2	1	29	45	1	10	26.6.08	1													
2008	963401B	8	1	1	46	51	1	10	24.9.08	2		29.8.08	10.1/8.4	GHN		3.5.11	11.8/8.5	2..8		1			
2008	304895D	2	2	1	18	28	1	3	30.9.08	2		4.9.08	GHN/6.9	GHN		20.7.09	9.7/6.9	GHN		1			
2008	221781D	6	2	1	11	27	1	3	1.5.09	2													
2008	366117D	0	2	1	33	37	1	10	8.12.08	2		3.12.08	GHN/6.3		6.3	25.5.09	7.4/7		1.4	1			
2008	294723D	5	2	1	42	51	1	1	2.9.08	2		18.8.08	9.6/7.5	MHN		22.4.10	9.0/8		2.9	1			
2008	328959D	6	2	1	33	37	1	3	16.10.08	2	VESSEL	8.10.08	8.6/5.3	GHN		26.10.09	6.9/6.3		3.8	1			
2007	984466C	0	2	1	46	48	1	2	21.3.07	2													
2007	069894D	3	2	1	44	49	1	4	30.7.07	1													
2007	079371D	9	2	1	23	22	0	1	26.9.07	2													
2007	131759D	8	2	1	23	18	1	9	5.11.07	2													
2007	984304C	0	2	1	37	49	1	10	14.3.07	2	DUPLEX,LM												
2007	139763D	14	2	1	43	37	0	9	28.12.07	1	CAME WITH NEPHROSTOMY												
2007	073767D	9	2	1	17	7	2	1	9.8.07	2													
2007	101816D	0	2	1	31	25	1	10	24.9.07	2													
2006	946823C	3	2	1	51	58	1	2	21.12.06	2													
2006	820984C	1	2	1	55	45	1	3	29.5.06	2	DUPLEX												
2006	870971C	0	1	1	22	22	1	10	25.10.06	2	NEPHROSTOMY AND LADDS DONE AT BIRTH												
2006	833162C	0	1	1	43	44	1	10	8.6.06	2	REDO WITH APPENDICULAR REPLACEMENT 25.8.06												
2007	998454C	0.4	2	1	43	53	0	9	29.3.07	2	REDO IN 2011												
2011	834806D		2	1	56	53	1		7.1.11		REDO											4.5	3.1
2011	872190D	5	2	2							REDO- DONE OUTSIDE, RIGHT NFK										13		